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**CITY LIGHTING AND DARK-TIME LANDSCAPE AS A
SERVICE**

Master's thesis
Curriculum in Landscape Architecture

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<p>This Master's Thesis studies a dark-time landscape and lighting solutions in landscape and cityscape. Nowadays cities are more complex 24-hours systems. Life around the clock emphasizes an importance of designs to create safe and pleasant appearance of public spaces also in dark-time.</p> <p>The aim of this Thesis is to find the principles of modern lighting and develop the process between lighting design and landscape design. In this Thesis the four lighting perspectives are 24-hour city, user-centered lighting, light as visual factor in space and sustainability and resilience.</p> <p>The theory is based on landscape architecture. Spaces can be created by lighting as well as lighting infra at day and at dark time is part of the urban environment. Furthermore, rapidly developing technology enables resilience solutions and still follows the increasing need of new lighting solutions to be more user-centered.</p> <p>The survey among professionals was made to find out the current situation between landscape design and lighting design projects.</p> <p>The lighting criteria concept (LCC) was created from the current situation of lighting design. Dark-time landscape was analyzed in different scales. Lynch method of spatial analyzes was used in bigger scale to analyze areas' landmarks, nodes and districts during the dark-time. In closer scale layers of lights analyze were used to find to the space and place feeling and to create more pleasant dark-time landscape.</p> <p>Two ongoing build environment projects, Jätkäsaari and Tripla in Helsinki were used as case areas. After Lynch method of spatial analyzes different kind of urban environments were taken to closer analyzing. These conceptual areas are a park, a hybrid space and a post-industrial site. In these conceptual urban environments were used as an example to create lighting as a service.</p> <p>The results emphasize the importance of dark-time experience of an urban landscape and a collaboration for achieving a new lighting solutions.</p>			
Keywords: urban design, lighting design, human scale, service design, smart, sustainability			

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Appendix 1 Axial coding of survey

1 INTRODUCTION

Cities have expanded and continue to expand as populations become urbanised. Cities are more and more 24-hour places where life goes on around the clock and a big part of human social behavior happens in dusk hours. People's round-the-clock life increases a usage of public spaces also during the dark-time and to operate 24/7 lighting is needed in the majority of public spaces. Lighting solutions are provided to urbanised areas to meet basic technical standards, but dark-time landscape and effects on people or environment are not usually in focus. This all results in suboptimal public space conditions for users as well as excessive energy consumption and disturbance to urban wildlife.

Light pollution is one of the serious environmental problems. Studies have proved that artificial light has huge impact on human well-being and it disturbs nature and affects urban ecology. Lightning causes also visual pollution if not sensitively designed. On the other hand poorly thought out lighting reduces usability of spaces and concerns as darker areas contrast with lighter areas.

Rapid development of lighting technology enables many new lighting solutions. New technologies have potentiality to reduce energy consumption, to be controlled more accurately, to vary the amount and type of illumination to suit different conditions and offer creative possibilities. Lighting infrastructure is a great opportunity for smart systems when cities are developing Smart city solutions. In the future lighting solutions are manifold and therefore it is important to manage lighting as a service in urban planning projects instead of implementing lighting sources according land ownership or building projects.

Lighting solutions are lighting services for users. User experience is an essential factor when creating good lighting solutions. In this research I review the current phenomenon of lighting and aim to explore user experience as a service. Additionally to the literature, I have interviewed professionals and carried out a survey among professionals working in a lighting designing field. The lighting criteria concept (LCC) has been formed from the basis of this information in order to develop lighting service concepts. Urban planning is carried out in different planning scales. At the master plan level Kevin Lynch method of

spatial analyzes have been used to analyze dark-time landscape. The aim is to analyze the potential urban spaces from a user perspective. The lighting service concepts have been made for the three potential areas. The improvements for the lighting service concepts have been made from the basis of the lighting criteria concept (LCC). The layers of light analyzes have been used to understand services as a user experience in a space. The structure of the research have been presented in the figure (Figure 1).

Light has also potentiality to create spaces in the dark-time. Therefore, there are great opportunities for landscape architects to work with lighting designers to improve public spaces for the benefit of a range of current and potential users and to utilise all the benefits of the new smart technologies to reduce unnecessary amounts of light, light pollution and energy consumption. The research questions are

- How to make a working concept to link lighting design and landscape design?
- How user experience is explored and social and environmental sustainability promoted?
- To what extent can lighting solutions enhance the usability of public spaces in the dark time and also maintain feeling of safety and security?

The term dark-time is used because it covers the dusk hours also before and after night time.

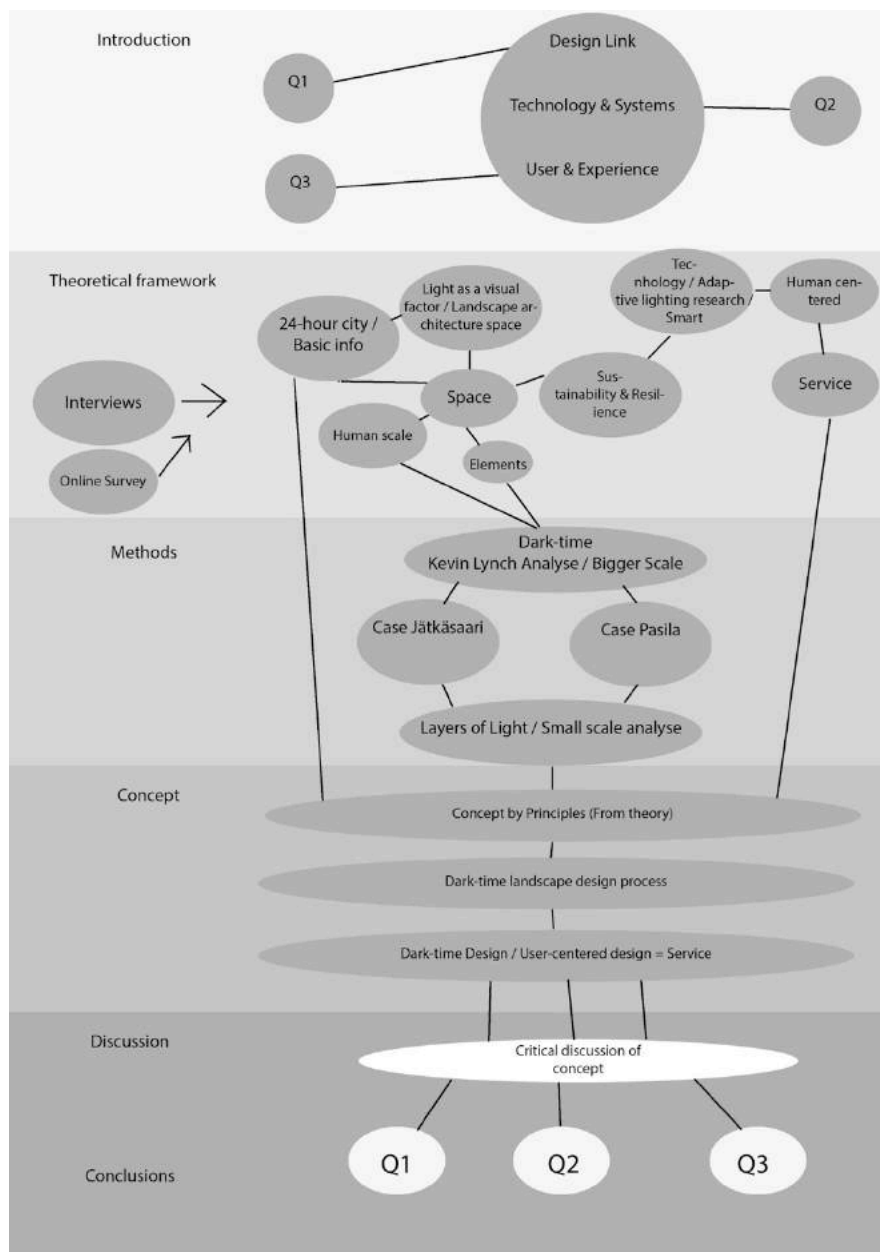


Figure 1. Structure of the research

2 DARK TIME LANDSCAPE

Global urbanization is phenomenon and the trend has been ongoing for decades. Nowadays 54% of world's population lives in the urban areas. The prognosis for that number is expected to grow up to 66% by 2050 (UN 2014). This creates urgent need to think more about the dark-time landscape and visual look. Some studies have proved that pleasant places can arise less crime (Painter 1996). Lighting can be an important factor to improve pleasant and safe urban environment for residents.

The dark-time landscape does not mean that darkness is dominant in urban areas. The world map from the satellite shows that there are in Europe's dark-time acreage more light than dark. Light pollution is announced to be an environmental problem (NASA 2017). Outdoor lighting is built at urban sprawl areas and for that reason lighted areas are expanding ongoingly. The dark-time landscape includes illuminated areas and dark areas in cities.

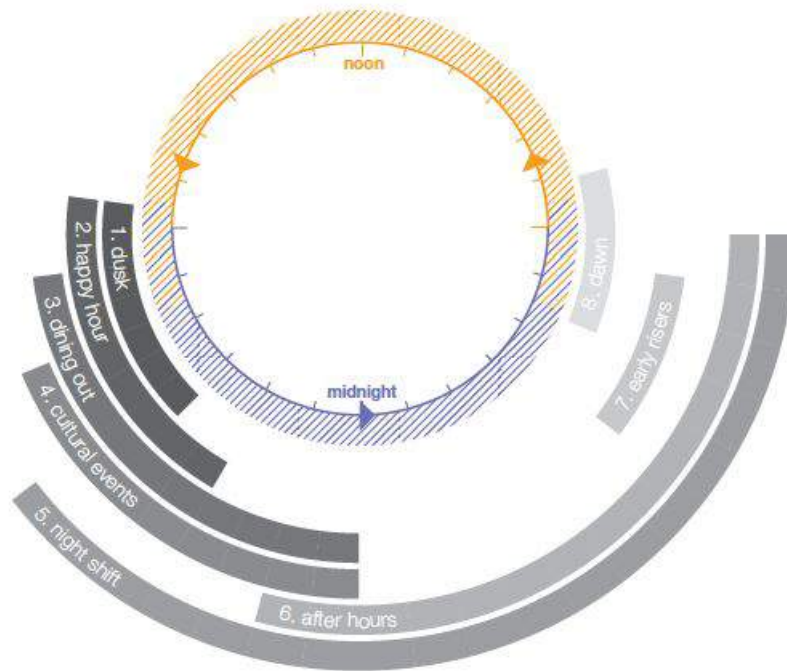
The balance and good lighting solutions in cities lighting are more and more well thought out in past years. Usually roads, yards and parks are illuminated, mainly for safety reasons. Traditionally lights such as spotlights are used to light landmarks or cityhalls in cities. Seasonal lightings such as Christmas lighting is very traditional. Some cities have been profiled as Cities of Lights. In Finland the most known city is Jyväskylä and abroad the cities Lyon in France and Allingsås in Sweden are well known. They are good examples for developing lighting in urban environment in many ways. New lighting solutions, art lighting and participatory lighting projects have opened a new appreciation of dark-time landscape and the meaning of it for cities and citizens.

Lighting technology is currently going through fast changes. Technologies are getting cheaper, but the challenge is to use them appropriately in city environment. There are different owners of properties in cities and that is why lighting designing should be done in a bigger scale than only concerning one project at a time. Lighting is also an interest of research. Informations are needed from the issues like how 24-hour lighting effects on people and nature. Dark-time landscapes consists of single solutions, but they create together dark-time landscape and the end user is human.

2.1 24 H – City

A couple of hundred years ago life in cities happened only daytime. The rhythm of human life based on light. First the oil lamps were used, later some lights worked with gas. The invention of electrical lighting was a great leap towards modern technologies and it enabled life also in the dark-time. The inventions have modified little by little our daily life cycle and they have enhanced living easier after light hours. Nowadays the trend is use of electricity efficient and resilient lighting solutions. Nowadays one of the designers challenge is to use the right lighting at the right place because there are so many options. (Arup2015: 14).

Cities are very complex systems with different user groups and their needs. Decision makers and designers have responsibility to answer for these multiformal questions with their more and more human centered designs and visions in any field concerning urban environment and human life. The 24-hour city is a phenomenon, which modifies how people experience urban environment. In the 21th century society markets and life go on after the dusk and this is an important fact to be thought out when planning also dark-time environment for citizens. (Arup 2015: 13)



The eight shades above typify an urbanised area in the Western hemisphere such as New York. Cities and their seasonal, cultural and climatic variations will chart their own shades of night dependent on local usage.

- | | |
|--|--|
| 1. Dusk: as the sun sets, depending on season, either the work day extends into the night, or daylight extends into the post work hours | 5. Night shift: factory workers, cleaning crews, around-the-clock services, such as transit, and emergency repairs and services begin |
| 2. Happy hour: the social extension of the work day, decompression time | 6. After hours: nightclubbing and after-hours clubs |
| 3. Dining out: the date, the business meeting, the special event, window shopping, strolling, meeting friends | 7. Early risers: the first shift arrives, outdoor markets set up, newspapers arrive |
| 4. Cultural events: going to the movies, theater, the ballet, concert or opera | 8. Dawn: the commuters begin to arrive, school starts |

Figure 2. Life after dusk (Arup 2015)

The dark- time landscape in urbanized areas is not one static state (Figure 2). It can be divided into several states according the time and the usage of it. The dusk time after sunset depending on season can be busy time for workers to return from work and start social and decompression time. This happy hour can be very busy and people rush in a city to meet friends and dine out. Furthermore, cultural events take place often around that time. After that urban area is mostly used by night shift workers and partygoers, whereas dark morning hours are already time for people to start work and go to school. To reach the targets of sustainability, cosyness and safety the dark- time landscape should be seen by the user perspective. (Arup 2015: 15.)

Citizens are the users and their experience should be taken into account in city planning and in dark-time designing. This information is in key role when new future cities and city landscapes are built.

2.2 City Strategies

Cities have made guidances and strategies for their lighting solutions. In centrum lighting has to be designed with taking the pedestrian scale in to account. Also important features in the centrum are the character of space and attributes of city districts (Forsman & Juuri-Oja 2003: 13). The outlook of lights and lamp poles should be in balance with surrounding cityscape. Especially in historical environments the most important thing is to find a neutral and a high quality choice for a valuable environment. (Forsman & Juuri-Oja 2003: 19).

The City of Helsinki is divided into the different areas. The city center consists of a shopping district, a historical center and also Kamppi centre and Töölö bay area. The biggest part of the center is for pedestrians which sets the main rules for lighting. In Helsinki center the lighting has to be high standard fitting to the environment and surrounding architecture. The strategy advises to use pleasant and the same colors as there are in the surroundings

The city of Jyväskylä has been recognized as city of light. It has been awarded for many light designs in the city centre. Their strategy is a bit more simple than the one in Helsinki because of the size of the city. Jyväskylä has zones as centre, commercial district. The city of Jyväskylä is a precursor in a different type of city lighting. They have had lighting experiments and some of them have remained permanent. (Kaanaa 2014)

The city of Tampere has a cityscape plan of lighting. The city centre is divided into the two zones of lighting quality. The zone I includes unique design and materials of lamp post, façade lighting to promote the city scape, whereas the lighting choices in the zone II are more standard. The strategy determines the lighting level of different parks, the en-

trances of the city, the important views, the lighted landmarks and the landmarks that should be lighted and the main areal centres (City of Tampere 2017).

3 SUSTAINABLE DEVELOPMENT

Cities have prepared sustainable development strategies. The concept of sustainable development with three aspects of ecology, sociality and economy have been known in many cities over 20 years. Sustainability has been guided by lighting standards. Main goals in traditional idea have been lighting regulations in illumination levels and energy savings (Casciani & Rossi 2012: 1). Comparing to social aspect, economical and ecological aspects are easier measured (Casciani & Rossi 2012:2).

When sustainable development is more a stable and a controlling system, resilience should be able to respond to unexpected changes. In urban planning multifunctionality, diversity, redundancy, networks and adaptive planning are ways to build resilience urban capacity. (Ahern 2011.)

Current best practice in urban lighting can be assessed by using standards BREEAM and LEED. They have been developed to manage sustainable lighting solutions. (Alkila 2016: 22)

3.1 Lighting sustainability

Sustainable development and urban resilience interact with lighting in many ways. Energy consumption play a big role in economy when sustainable development is promoted. Nowadays all artificial lighting including indoor lighting consists 19 % of the global energy consumption. It is estimated that all artificial lighting will increase up to 80 % by the year 2030. Lighting technology markets will increase also about 20 % per every year when new energy-efficient and new smart LED- technologies are introduced to markets (Arup 2015: 9). Recycling possibilities and life-cycle of lighting equipments are important in terms of

ecological and economical solutions. It is also a fact that wasted energy means costs in economy and due to this sustainable solutions in planning and design should be considered.

From ecological perspective artificial lighting in nature is a threat. It is known that lighting disturbs nature and affects urban ecology. The expectation is and some studies have proved that artificial lighting disturbs ecology, physiology and behavior of urban fauna even though there are differences in tolerance and in sensitivity (Perry, Buchanan, Fisher, Salmon & Wise 2008). The research information is not adequate at the moment. The challenges became also because different species are diurnal or nocturnal. Some of the species have already used to urban lighting and co-residence with humans. It is also obvious that some species benefit of artificial lighting where as it can be understood that the effects in long term beneficial for another may have negative impacts to another. (Perry et al. 2008.)

Natural and semi-natural areas are important parts of urban environment and a city structure. They are habitats of fauna and they usually are used as recreational areas by residents. Especially water and pond areas are very sensitive places in terms of artificial lighting. Not only ambient lighting, but also skyglow can affect disturbance. The study of amphibians and reptiles (Perry et al. 2008) brings information about species living in aquatic environments, where as there many wildlife species that have not been studied in terms of light pollution. The target is that the studied species could give information how to solve the light pollution problems. Bats are nocturnal and ideal to be tested. The study proved that light anthropogenic lighting can affect negatively on bats' foraging and reproduction. (Stone, Gareth & Harris 2009.)

City is a complex system in many ways. There are also other factors such as noise, chemicals and habitat destruction affecting wildlife. The study of song birds explored that artificial night lighting had several consequences on song birds' timing of singing and reproduction. (Kempenaers, Borgström, Loes, Schlicht & Valcu 2010.)

It is now the important task to make lighting solutions which also consider the effects on wildlife. Unnecessary and too bright lighting can be turned off and natural not lighted barriers can be planned between light sources and wildlife. New technologies will offer solutions as soon as there will information about what solutions benefit wildlife. (Perry et al. 2008.)

Social aspect is important. Not only safety, but also possibilities to use urban environment in new ways in dark-time.

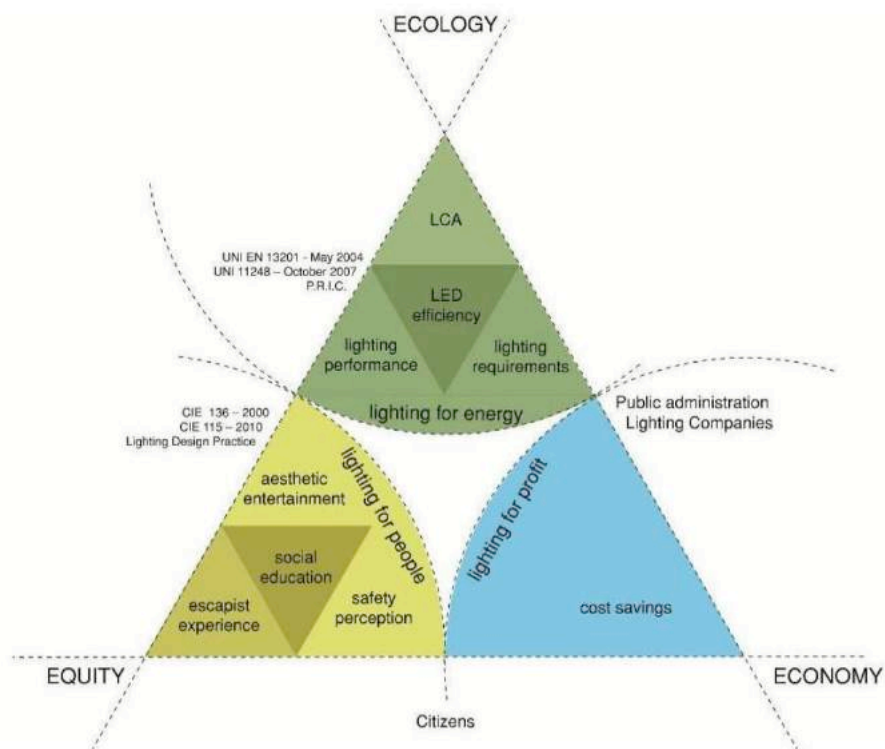


Figure 3. Sustainable lighting diagram (Casciani & Rossi 2012)

Sustainable lighting diagram (Figure 3) shows the sustainable lighting balance. It is much more than just an economical aspect which in the end is just to save money. Ecological perspective includes LED efficiency because it saves energy. New technologies also save money and energy.

Lighting is for people. Sustainable lighting considers people's perception and experience of the urban place. A pleasant city lighting can raise activities, promote people's equity and aesthetic entertainment. Social aspect of sustainable lighting includes aesthetic and experiential features. The diagram shows that social sustainability contains features that can im-

prove the use of public spaces and bond between people and night-time city through lighting. (Casciani & Rossi 2012: 2.)

3.2 Lighting resilience

Urban resilience is a capacity of a city to adapt changes. These changes resonate with people, business and different systems and they rise from ecology (Ahern 2011). An organization working with this development called Arup has launched the city resilience framework. It tries to open the complexity of the city resilience and to help cities to build resilience strategies. The four dimensions are 1) Health and Well-being, 2) Economy and Society, 3) Infrastructure and Environment and 4) Leadership and Strategy (Arup 2017).

A few cities have prepared their resilience strategies. Lighting resilience strategies have not been made, but lighting can be connected to the many targets. According to Velje Denmark 2015-strategy the main pillars to build up a resilient city are:

1. Co-creating city,
2. Climate resilient city,
3. Socially resilient city
4. Smart city

A few targets to integrate lighting have been raised up in the figure 4.

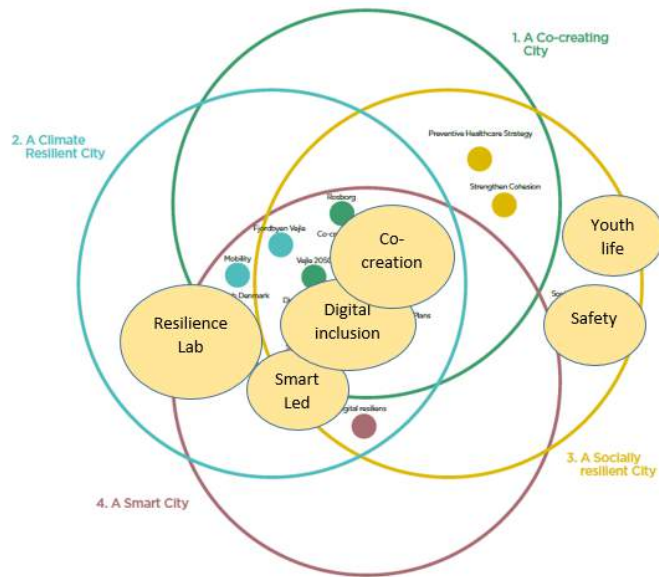


Figure 4. Vejle resilience strategy 2017, (modified by Simo Suomalainen)

3.3 Leed & Breeam certifications in urban lighting

LEED and BREEAM are global environmental certification systems used in the environmental impact assessment. The system gives scores by the criterias. It evaluates buildings and their enviromental features and gives the score based on the criteria. In Finland the most used certificate criteria in use are LEED and BREEAM. There are also alternative criterias in use in the world. Certification systems give scores for example from energy consumption, energy efficiency, water consumption, land use and material and waste management. The system also scores health impacts. (Alkila 2016: 22.)

LEED in outdoor lighting

The LEED-certificate system includes strict regulations which try to prevent unnecessary light and firmament lighting. There are regulations in the terms of enviromental lighteness standards for directing lights right in order to prevent disturbing lights. LEED-system sets a value that regulates the specific area. A problem in this certification system is that it does not take into account situation that the light from a plot or a house can be benefit for a parking lot or for a pedestrian path locating next to it. LEED sets regulations also for lumi-

ous intensity for lighted billboards. Regulations are 2000cd/m² at the daytime and 200cd/m² at night time. (Alkila 2016: 23.)

BREEAM in outdoor lighting

Assesment of outdoor lighting pays attention to SFS-EN 12464-2-standard lumious intensity and also for luminous efficiency of the lamp. The lumious intensity has to be at least 60lm/W. To prevent loss of light, disturbing lighting and firmament lighting outdoor lighting plan needs to follow the CIE recommendations and standards. Outdoor lighting should aslo be able to switch off automatically during night time. If the outdoor lighting is necessary also during the night hours it had to be able to dim in to lower levels of CIE standards. (Alkila 2016: 23.)

4 USER CENTERED DESIGN IN LIGHTING DESIGN

When developing a lighting planning process also users and user experience are an important part of it. User-centered design and participatory design are new focus points in research and implementation of lighting. Lighting designing was earlier carried out from technical and energy-orientated perspective, whereas nowadays the development of technology brings new opportunities to participate users into planning and implemenatation projects. Additionally to this it is important to get information about user experience. Implemented projects enable direct feedback and increase in knowledge. Professionals working with lighting designing in Helsinki have been interviewed for this Thesis to find out about the current solutions and knowledge about user experience in lighting designing. All user experience is not so evident, but it has been explored in different researchers. Safety and accessibility are important targets for all users in urban environment. Furthermore, light pollution and the effects on human health are essential points to understand in lighting design processes.

Lighting installations usually get positive feedback from users and city residents. An environment illuminated by different colours creates aesthetic experiences which can create more preference in a surrounding environment. Light installations bring urban environment into life and they develop good conditions for well-being in every day life. Light that adapts movements with sensors produces a safety feeling for the user. A person experiences own living environment preferable if he or she can take part in modifying it. (Pihjalaniemi 2016: 148-149.)

User experience can be explored in human centered design process which has been standardized. The standard ISO 13407 (Table 1) determines the actions in the process. Firstly, it is important to specify requirements of users and before products or systems are ready, they have to be evaluated against requirements. (ISO 13407)

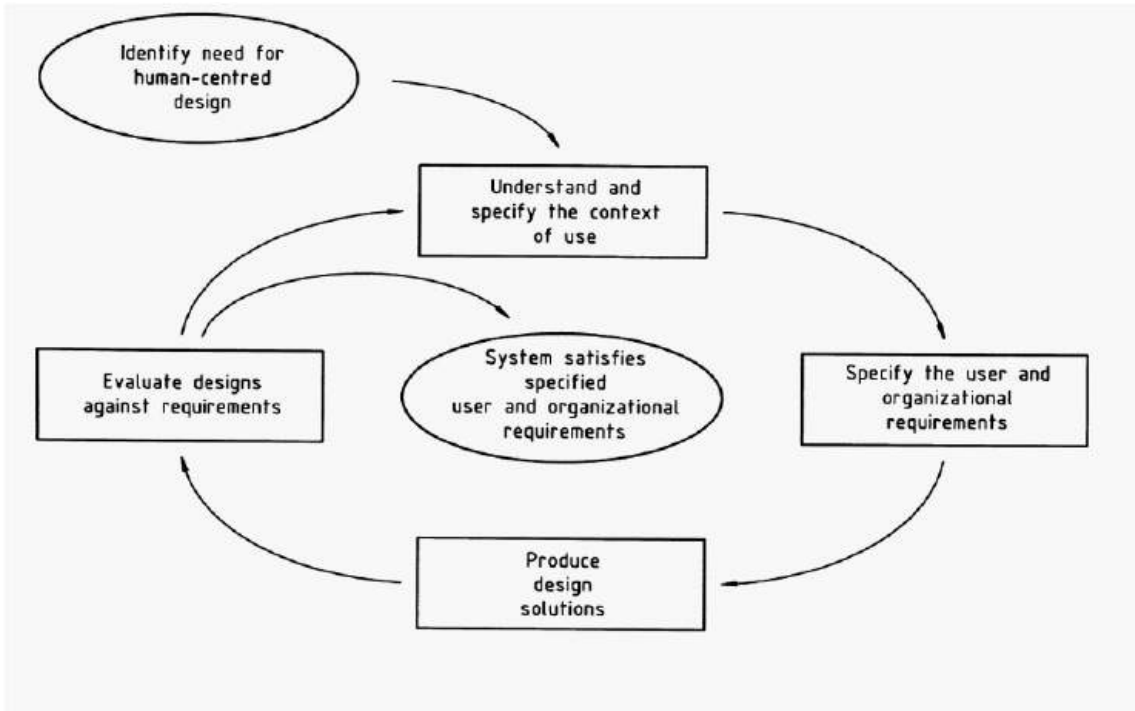


Table 1. ISO 13407 Standard about user centered design

The main purpose of a lighting design is not only to save energy or produce energy efficient solutions, but also to create functional living, learning and working environments for peo-

ple. In urban environments light is often used as a tool for information and communication. For example traffic lights, signal lights, neon lights and lighted billboards create informative environment for users. Advertisements have recently become more popular along the roadsides and in public spaces. This might not always be the best case. Information merges in our built environment from which it effects imperceptibly in forms, moves, sounds, colours, different temperatures and in lights. (Pihjalaniemi 2016: 29)

4.1 Safety

Safety is one of the main targets that lighting should produce. It is often thought that adding light spots is the solution. User experience about perceived safety and studies about safety in urban environment argue with the previous practice (Lyytimäki, Tapio, Assmuth 2012).

Lighting is not only light but also contrasts and shadows. Dark-time in a city can be frightening in a different way than at daytime. Social control is small and the risk of threat is big. Darkness provides hiding places and a victim cannot observe environment in the same way than during the daylight. Lighting can provide visual control and enabling sight around environment. (Nikunen, Koskela, Schakir 2013: 21) A high pitch of lighting can increase fear, because unpleasant features in an environment can stand out. One can also feel like being under observation. (Nikunen et al 2013: 21)

The project Lights, Shadows and Dangers (Valo, Varjot & Vaarat) studied perceived fear in three different public parks in Helsinki. The results proved that wide and continuous lighting combined with lighting of details was most convenient. The structures of the parks play an important role, because a wide and open structure is also wider in the dark time and there are no hiding places. Bonds, rocks, sculptures and nice views were experienced as comfortable places in dark-time. The feeling of mystery can promote comfort feeling and it can also be a reason of fear. Mystery should be created by considering also lighting in terms of orientation, escape and visual control. (Nikunen et al 2013: 71).

The study found out that people like constant lighting and they described that good lighting was smooth. They also appreciated lighted details and objects in the surrounding environment that also promoted a feeling of safety. Predictable and sufficient lighting was seen good. The opposite experience was reported from point-formed and bright spots, blue light and too practical lighting (Nikunen et al 2013: 115-117).

New technology can increase safety feeling. Smart lighting along roads have been implemented to bring more safety. Smart lighting light on when there are users at the area. Guided lighting reacts on move and brightens up for road user. Waneing lights create more natural atmosphere when roads users are not near. (Hietala 2015.)

Adaptive lighting was tested in Lahti, Finland. In the project lights were adjusted to adapt the amount of people and add light if the road was used. Important point raised from users that in terms of safety feeling it was important to see ahead. Lighting level should be enough high to provide safety feeling so people could enter the area. (Huuskonen 2016.)

4.2 Lighting pollution

Lighting pollution is a term for negative lighting impacts such as glare, sky glow and light trespass. It is quite difficult to know to what extend lighting promotes safety and good experiences and when it will be overused and misdirected causing glare and bad experiences. There have been practices to limit pollution like prevent direct upward light, use necessary lighting level and appropriate lighting and time for the tasks. It is important to consider this because of the effects on human health. Lighting pollution causes decrease in melatonin production the symptoms being changes in a circadian clock and causing performance, alertness, sleep and metabolic disorders. (Cinzano, Elvidge, Keith, Haim 2010.)

Experience about lighting pollution is personal. The effect can result from personal factors, but also from reflection effects which can not be know beforehand. New technology, regulations and laws can help to reach good and healthy living environment. The basic principles are 1) no luminaires directly or at and above the horizontal, 2) light only the neces-

sary area, 3) avoid overlighting 4) shut off lights if not in use 5) aim for zero growth for the total installed flux 6) limit the wavelength blue light (Cinzano et al. 2010.)

4.3 Colour of lighting

Studies have found that colours of light have huge impact on people. Using light that adapts with daylight in hospitals has been found to nurture healing time of patients. Mood and gender have a connection to respond to light spectrum. Women's problem-solving ability decreases in warm lighting and increases in cold lighting. Men's problem-solving ability reacts vice versa. Studies also show that lighting can cause positive behavior for example balance mood and expanding the focus. (Arup 2015: 29.)

When lighting pollution was studied it was found that blue light causes more pollution than red or green light. The explanation is that s shorter wavelength radiation (blue) scatter in the atmosphere more than long wavelength radiation red and green light. Considering colours of light it is possible to avoid lighting pollutions and protect human well-being in many ways. (Cinzano et al. 2010.)

4.4 Accessible lighting

Accessible lighting is a part of accessible environment and a right of universal environment for all people. According to the principle all solutions in accessible environment, are to support independency. Accessible lighting interrelates to elderly and vision impaired people. The impaired eyesight is due to eye illnesses and due to aging. Lighting can help them to avoid accidents and hazards. Difficulties can be orientation, estimation of distances, reading signposts, hitting oneself, stumbling or falling down. (Laitinen 2017.)

The criteria SURAKU 2008 for accessible environment includes also lighting. Signposts should be lightened in urban environment. In parks lighting should be guiding, constant

and changes should be emphasized. The main elements in accessible lighting are guiding lights and clear contrasts. (Esteeton 2017.)

The study about lighting and contrasts in public station environments (Ministry of Transport and Communications 2006) determines necessary needs for pedestrians:

- 1) In order for one to be able to perceive the entire space lighting should be continuous in indoors and outdoors. Walls should be lightened in order to be perceived space as a whole.
- 2) Good colour reproduction light should be used in public station environments.
- 3) Direct glare should be prohibited. Eldery people are more sensitive to glare. When using lights at the field of vision, they should be glare shielded.
- 4) A station building should stand out as a public building.
- 5) Main entrances should be accentuated with light. So it stands out as a public building.
- 6) Level differences should be lightened so that contrasts are clear. The standard lighting fades out the differences. Different light colours or side lights can be used.
- 7) Changes of day light can cause strong shadows or need of lighting when it is a cloudy day.

In parks and other public spaces it is important to light paths and ways to promote accessibility. It is also possible to illuminate special features that need to be brought out in the environment. In parks it is important to use a comprehensive lighting to enhance feeling of safety. In historically valued places and landscapes also accessibility lighting should be adjusted into the theme of the area and environment. (Laitinen 2017.)

In playgrounds it is important to think that at least a part of the playground is lighted for visually impaired children. By the help of right lighting children will find functions from a park and are able to play and go freely there. (Laitinen 2017.)

Stairs should be illuminated meticulously regardless of where they are located. Staircases are an important subject in terms of accessible lighting. Illumination of stairs must avoid to use straight lighting from downlink or uplink, because it softens the contrast and may cause glare. In staircases it is important that every step gets enough light. Extra lighting is best when it is situated at the side of the stairs to avoid the glare. With new technologies it

is possible to install lighting in to a handrail (Laitinen 2017). Lighting in handrail works also as a leading element and visually impaired users can notice stairs and their direction. Also the material colours of stairs need to be considered in planning. Generally light-coloured materials are better in staircases. Every step should have a guidance track in the edge of a step in terms of accessibility. It communicates to a visually impaired user the location of edges of steps. (Laitinen 2017.)

The city of Helsinki has defined levels for accesibility in different areas. In cities streets are at the basic level. Station areas are at a special level of accessibility. At this level also lighting is designed more meticulously than in street areas. (Rantanen 2017.)

4.5 Adaptive lighting

Adaptive lighting can be explained as an adaptive system in which the design is implemented by the information which has been gained from the environment and its users. With gathered information it is possible to install and control lighting that works from the base of user information creating an illuminated environment. Adaptive lighting creates an experiential environment which can make an impact on user behaving which effects again on adaptive lighting. (Pihjalaniemi 2016: 16.)

One form of adaptive lighting is interactive lighting. Interactive lighting can be implemented in many ways. They are different kinds of lighting implemented together with users, participation of users in communication and realization. (Pihlajaniemi 2016: 29)

Nowadays interactive lighting is often used and intergrated into an urban environment. Shops and advertaising billboards are adapting to show advertisements on walls. Lighting is increasing by interactive lighting installations. (Pihlajaniemi 2016: 29)

An interactive lighting experiment was made in Copenhagen by installing one ”adaptive lamp”-prototype. The experiment had three main goals; a functional, a sustainable and a social goal. A fuctional goal was to adjust the light by the activity and location of a street. The sustainable goal was to use energy-saving, dazzling and even solar powered LED-

lights. The social goal was to use light as different effects and to stimulate the social and playful behaviour of people. Lighting brightened when person approached it. Lighting also changed colour from cold white to more warmed colour according to the amount of people and their velocity in street environment. (Pihlajaniemi 2016: 31)

Participatory lighting is also a part of adaptive lighting. It can be attached to participating planning, sub-plans, residential participating and art projects. Involving stakeholders in planning enables communication between stakeholders. Non-designers are usually other users and external influences for example professional groups who have different goals in projects. Participatory planning includes broadly different professionals, tools and techniques that usually can be used in commercial, societal and researchal contexts. (Pihlajaniemi 2016: 31.)

User based lighting has been introduced by Pihlajaniemi in Table 2

Table 2. User-based lighting forms (Pihlajaniemi 2016). Modified by Simo Suomalainen 2017.

Adaptive Lighting	Interactive Lighting	Participatory Lighting
<ul style="list-style-type: none"> Adaptive lighting based on user and information Data gathering and reacting adaptive lighting 	<ul style="list-style-type: none"> Lighting in interaction with urban environment and users Commeric advertising lighting Art lighting 	<ul style="list-style-type: none"> Participating process that includes variation of different parties Participating residents in lighting designing etc.

Sen-City project research by case study smart lighting in Lahti Harbour area. The aim was to develop a smart light pole in to production (Huuskonen 2016: 15). In case study enliven and districts historical aspect came to prominence from user information. These were the things that people were hoping to develop with digitalization. Tree poles considered to fit in the environment, but other than that more lighting wished to add to the area. In workshops different coloured light installations shared opinions against and behalf. Guidance and communication can be a part of lighting and in workshops people were hoping this part to be developed in future.

Adaptive lighting can also cause unsafety. In a case study adaptive lighting was used so that the lights came up at those parts of the road where a person was walking. Surrounding environment was dark and that made the area unpleasant and a person felt unsafe. (Huuskonen 2016: 96- 100.)

The social light movement is a philanthropic movement and it has been found to improve lighting for people. The main aims particularly are those who unlikely have access to quality illumination in their surrounding environment. The social light movement makes projects in suburban areas and creates a network for lighting designers and other interested parties to collaborate. The collaboration brings lighting installations to everyday environment. They involve communities in the actual design of their own environment. Suburban residents will participate in to the planning process and all the way to the implementation. Implementations usually are art lightings with lots of colours. Part of the special lighting implementations will remain in the environment. One goal is to draw attention and understand in politics that every place is important in terms of lighting and other activities. (The Social light movement 2017.)

4.6 Art lighting

Improving dark-time lighting in urban areas does not always require permanent lighting solutions. Art lighting can be created for a short time or for a long time. Usually the goal is to enhance the environment. Typically art lighting is impelented in event-based happenings. Artlighting events can be give a spark for longer term lighting implementations in the urban environment when people notice how much the lights can enliven the cities. (Rantanen 2017.)

Guerilla-lighting is a light event the goals of which are to pay attention to an urban area lighting and to show every day city areas in a different way by utilizing new lighting solutions. The event can be carried out with flashlights and with a group of participants. The main goal of the Guerilla-lighting event is also to prove that high quality lighting in urban environment increases comfort and safety feeling. Guerilla-lighting events have been orga-

nized across the globe. (Guerilla Lighting 2017). First Guerillas in Finland were held in Jyväskylä and in Helsinki in the year 2008. A Guerilla light event has been realized in Tartu in 2014.

Illuminating art pieces or statues, light sources need to be well hidden to serve the art work. The aim would be to find a good place for light sources so the main focus still is on art work. In pedestrian areas art lighting and light fixtures should be in balance with surrounding architectural, functional and historical features.

Trees can be an object of art lighting. In parks trees are a challenge for finding perfect solutions for locating lights. When working near trees it should be considered that the light poles or infrastructures should not be installed too close to a tree. The roots of trees can be easily damaged by any sort of excavational work near them. New technologies allow unnoticeable lighting installations. With different sizes of spotlights the light can be managed from different distances. (Laitinen 2017.)

4.7 Smart City

Smart city does not just mean single intelligence. Smart-term usually means concepts which include new smart and digital technologies to promote urban life and services. Smart-cities can be divided to the three dimensions which are 1) a human dimension, 2) an institutional dimension and 3) a technological dimension. The human dimension includes a person and creativity. Also education, learning and knowledge have a key role in the human dimension. The institutional dimension refers to a decision-maker sector. Governments and other public sectors are doing decisions to increase smart systems for supporting new acts, economical growth, sustainable development and for supporting the well-being of citizens. The technological dimension refers to new innovations and systems which are taking people and society forward in development. (Huuskonen 2016: 35.)

Smart technologies

Information and communication technology will grow because processors, sensors become cheaper. LED and smart technologies are tools to understand complex urban challenges in new ways. With smart technologies lighting can be more adaptive and responsive to its surroundings. It can adapt better with environmental, social and contextual needs. Different kind of sensors and the Internet of Things are pioneering new intelligent solutions that can be installed in lighting system. Intelligent solutions can also respond to activities and conditions and forward that info by using for example lighting infrastructure.

The project Sen City project has studied Smart Lighting. It has founded out that lighting is a communication tool and it can be used to share information in a city environment. It can be a guiding element in orientation. Lighting can be changed according to the need of it and it can create different atmosphere and feeling. The main targets of the projects are to combine safety, energy efficiency and comfort in the city environment (Hietala 2015).

5 LIGHTING AS A VISUAL FACTOR

One aim with lighting is to create specific image trough the city. It is an important factor for tourists and other visitors in cities. Part of the city lighting is created by city-infra like street lighting. When light is seen as a visual factor, it is possible to create different kinds of experiences in the environment in dark-time.

Light highlights details and it also creates an atmosphere of space. Additionally with accent lighting elements it is possible to improve visual controllability and indentifiability in different kinds of operational environments (Ramboll 2016).

5.1 Light as a creator of space

Lighting supports the city space for example to identify public spaces. Lighting solutions should be based on an analysis of citystructure, patterns and features. A public space can be brought up with lighting and desirable features in the cityscape can be highlighted. For

example public buildings such as a church, a library or a city hall can identify the space. Lighting gives a possibility to observe city spaces in the dark-time, but also on the other hand it enables to create some illusions that would not exist during the daytime.

Spaces and places are essential in architecture. Architecture is always interaction with humans. To reach good quality urban environment also in human scale architect Jan Gehl has develop evaluation tool for public spaces (Gehl, Gemzøe, Kirknæs, Søndergaard 2006). In cityplanning the target is to contribute good quality urban environment. Market places and squares are typical meeting places, but social interaction can happen also in other places that people find good quality places. The concept ELP (experimental landscape places) defines spatial dimensions and experimental dimensions and how they are connected (Thawaites, Simkins 2005). According ELP spatial analyzes spatial citystructure consists of

- 1) Open space structure that is space between buildings or other elements
- 2) Geometric spatial centres
- 3) Visual corridors
- 4) Movement corridors
- 5) Transitional spaces
- 6) Areas which is a combination of spatial centers

To contribute good quality spaces and places also in dark-time, it is necessary to understand elements that create space and use them also in dark-time designing. Landscape architecture defines space in to three different dimensions or layers. One layer is the ground. The vertical layer consists of walls and borders of space. The third layer is the sky or the space above the head. Design elements of all these layers are structures, vegetation, water and the combinations of all these. (Dee 2001: 34.)

A human scale is a broad concept and it has many meanings, but usually it determines the relation between the surrounding scale and a human. Human scale brings forth positive feelings at the same time when the surrounding features are in a sufficient scale with a human being. These positive feelings involve comfort, safety feeling, relaxation, orientation and the feeling of togetherness with the surrounding environment (Dee 2001: 47). The feeling of space is also in relation with the concept of space and it is also depended on a context of space. Public landscapes are experienced in different scales. The scale of space

changes between outdoor and indoor spaces. A natural or a countryside landscape creates different reactions compared with the same size of spaces in the city environment. (Dee 2001: 47.)

Lighting can create space experiences in darktime. The city spaces and the elements according Dee (2001) are:

1) Street space

Street space in cities creates space usually between buildings. Street spaces can be important public spaces for people in city environment. Cities have strategies and regulations to create good environment also for pedestrians. Street trees, furniture and visible lighting infrastructure are important factors when a pleasant environment is designed. (Dee 2001: 106.)

2) A curving element

Curving elements create their own characteristic space in a city. They are good guiding and leading elements. A curving element can be on the ground or it can be upon the vertical level such as walls and buildings (Dee 2001: 106)

3) A ground element

Ground elements are affecting essentially on the feeling of space. Materials and colours have their influence on the feeling of space. Light coloured materials present more open space feeling, whereas dark materials can make the space feel more tight and smaller than they in fact are. (Dee 2001: 108.)

4) Tree lines

Treelines are a delimiting factor in the landscape. Canopies and foliage can block the views on sky which makes the space feel more closed. A tree line creates a tunnel-like feeling limiting the view to only what is ahead and what is behind. Treelines are also leading and pacing elements in landscape. (Dee 2001: 106.)

5) An archetypal form

An archetypal form is a similar form or a physical order in a human environment that repeats and produces same functions. An amphitheatre is an example of that. The form has been a focus of a interest for thousand decades. (Dee 2001: 106).

6) A metaphor

Independent elements in the same space create a metaphor. (Dee 2001: 106). Light and water can be combined with the sound.

7) Symbolism

A symbolic space character means that the space has a feeling from someother space. Symbolism is almost the same as a metaphor, but symbolism has to be recognized in human life. (Dee 2001: 106).

5.2 Lighting infra

Good lighting supports activities of people during dark hours and dark seasons of the year. Lighting creates the environment to be safe, understandable and beautiful. A good lighting solution is an outcome of a specific analysis of a design area and knowledge of architecture. It is important to take a cityscape and its connections into a larger entity on the base of lighting solutions. Lighting furnitures need to be in balance in cityspace and in a larger picture. A street, district and a facade lighting and advertising lighting must be in a harmonical balance in a city space. (Forsman & Juuri-Oja: 13.)

City furnitures and visible lighting infra are important part of the place making. They include all objects, equipments and appliances that are placed at public areas in cities. They

also determine space and orientation in cities and additionally they create cityscape. That is why a good design is necessary (Junttila & Koivistoinen 2002.)

The scale is an important factor and the dimensioning lighting posts is connected to the use of the area. Street and market places can differ from one area to another and due to this the same concept can not be used everywhere. Important factors are also colours and materials that should be taken into account. Lighting posts are visible in the city structure and create a continuous run in a townscape. (Junttila & Koivistoinen 2002.)

General lighting principles in street areas regulate designing of lighting. Light sources in street areas are placed at the height of 8-10 meters, whereas the 4-6 meters height is convenient for the pedestrian environment. The effect of lighting infra stands out especially for pedestrian areas and creates image and place making (Junttila&Koivistoinen 2002).

Lighting poles are usually placed in the sides of the streets. They can also be utilized for other purposes and in that way an amount of barriers for city maintenance can be diminished. Poles are often placed along city tree lines and it is important to consider that trees have space to grow and despite that lighting is unimpeded. (Junttila&Koivistoinen 2002.)

Materials and design of lighting infra varies. Poles and lamps are most used lighting equipments and they can create spatial rhythm in environment (Figure 5).



Figure 5. Rhythm created by lighting poles

Lamps can be hung upon street and market areas in dense city areas. (Figure 6)

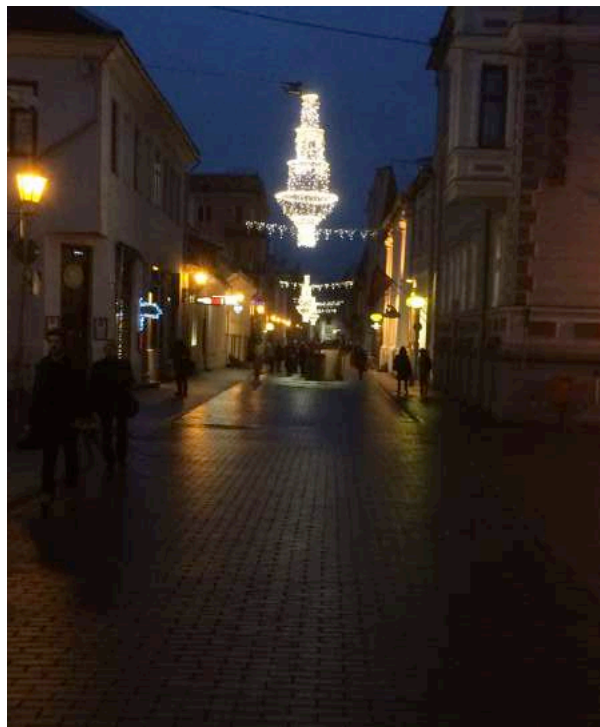


Figure 6. Lights hanging above street create a roof in pedestrian scale

Lighting infra can be visible and contribute the era of the environment. The importance of lighting models is significant in historical environments (Figure 7)



Figure 7. Lighting infra in an historical environment

Lighting infra can also be invisible at the daytime. New technology and LED lighting enable integrated lighting in buildings and outdoor furniture and embedded lighting is used a part of a construction structure.. During the dark-time the light creates a different atmosphere, because it is a part of the element. Integrated light can also be used in poles and it creates a vertical rhythm (Figure 8).



Figure 8. Vertical lighting

Smart lighting poles

Smart lighting is a technological system installed in a lighting pole or it can be integrated technology. Lighting infra can include different kinds of sensors that measure surrounding environment. An individual sensor in a pole does not make lighting smart, but when technology creates a network and enables to gather data and communicate with other sensors in lighting infra it is smart lighting. Smart-lighting poles could also process the data to be meaningful to the user. In outdoor lighting adaptive lighting presents interaction between people and sensor technologies. (Huuskonen 2016: 76.)

It is more probable that cities are transforming into more and more technology orientated. For example by the growth of 5G network technology cities will need more base stations. A lighting infrastructure and other poles in the cities would be a perfect place to set these technologies. (Huuskonen 2016: 102.)

5.3 Colours of light

Light is electrical magnetic radiation and the visible part is measured by different wavelengths. Different wavelengths occur in different colour perception. Light sources and lighting solutions colour perceptions are measured and compared in a colour temperature the scale of which is Kelvins. If the number is low (2000-3000K) then the visible white light is seen as a warmer colour. If the number is higher (4000-6000K) the white light will be seen as more cold coloured. For example the old incandescent bulb corresponds to 2500K and clear sky is above 10000K. (Figure 9). (Forsman & Juuri-Oja, 2003: 10.)

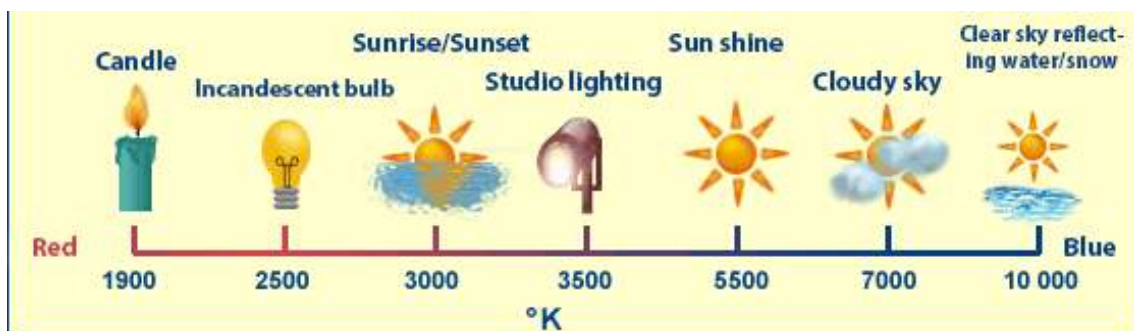


Figure 9. Colours of light

Because of the rapid development of lighting solutions LED-lights will fit in every lighting needs. LED-technology enables more colour options in lighting. They can produce pleasant warm-toned (2700/2800/3000K) lights and also cold-toned (4000K) lights. LED-technology has enabled the so-called day-light-lamp (6500K). LEDs produce full light immediately also during the winter and in minus degrees. LEDs last a long lifetime and they last about a million on/off-switches. LEDs have a spectrum that does not make colour distortion. (Airam 2017.)

High-pressure sodium lamps belong to gas discharge lamps. Discharge lamps are different from day light and incandescent bulbs because it does not have all light wavelengths. That is why a high-pressure sodium lamp does not repeat all the colours. Then the colour rendering index is lower. (Forsman & Juuri-oja, 2003: 10.)

5.4 Layers of light

All lighting in cities come from different light sources. All light sources on public area create contrast. Light is used for many purposes in the urban areas. Light can be used to highlight special features of architecture (Rantanen 2017). Light sources in the cities are usually street lighting, ambient lighting with a contrast of advertising and sign boards. (Arup 2015: 25)

The *Urban Design Compendium* points out importance of planning lighting for pedestrians by using different layers of light sources (Arup 2015: 25).

The ambient layer of lighting in space means a basic background layer. The main function of lighting at that layer is to provide safe lighting across the space and in that way space to be safely accessible. It also provides function of the space (Arup 2015: 25).

1) The accent layer of lighting provides contrast in space. It is to draw users' focus on a desired thing.

2) At the orientation layer light is to delineate space and enable navigation and wayfinding.

3) At the feature layer lighting is to provide an extra layer of a visual interest. In a cityscape lights can highlight special features of architecture or other special elements.

6 DARK TIME DESIGN

The interest about urban lighting has increased by urban planners and designers. The main reason for that is changed way of use of public spaces and 24-hour life. Urban lighting makes cities alive after sunset. (Casciani & Rossi 2012). For this research actual picture of lighting design and urban planning was clarified.

6.1 Lighting designing in context of urban planning

Lighting designing is often based on standards and regulations and the lighting plans are often made by electric engineers (Rantanen 2017). Street lighting which is a main source of our lighting in the cities often serves only cars and not so well pedestrians (Arup 2015:32). Urban areas have been designed to be pleasant for users at daytime and now the trend seems to be concentrate also designing areas to be pleasant in the dark-time. One difficulty seems to be involve user experience into planning processes. The other challenge is the discussion between professionals. It is lacking tools to bring lighting planning into different levels of urban planning (Rantanen 2017).

Urban planning is done in different scales. Before land use plans, pre-project plans for the area can be made. Lighting can be already in discussion and the strategic plans of cities can be realized in pre-project plans. The master plan have different scales depending on the size of the area. The scales vary for example between 1:10000- 1:30000. The city plan is more detailed plan and the scale can be for example 1:1000- 1:2000. After that comes sites plans. This means that the lighting plans are also made in different scales and different tools are needed for discussion. It is important to observe entity city environment in terms of lighting, because lighting architecture and lighting sources in the neighbourhood affects to any other new project.

6.2 Present situation

The present situation of lighting designing in urban planning process was crucial to find out in order to develop lighting concepts for planning processes. The survey was carried out among professionals in Ramboll Group A/S. The content of the answers were formed under the head themes and the frequency of the answers made the order in the table (Table 3, Appendix 1)

Table 3. Common themes of survey

The content of the answers	Forming a head theme	Spesification
Sustainability and resilience are the most important factors in good lighting solutions	SUSTAINABILITY, RESILIENCE, USER EXPERIENCE, SPACES	Energy consumption , lighting should create places for people in dark-time
Elements and details in different scales are prior to be developed	SPACE, USER EXPERIENCE	Human scale
Dark-time designing needs more detailed designing and also unlighted places should remain	USER EXPERIENCE, SUSTAINABILITY	Lighting pollution
Modelling (3D or other) helps in visualization, but feedback from real cases are needed	USER EXPERIENCE	
Lighting solutions create the identity of place	USER EXPERIENCE, TECHNOLOGY, RESILIENCE	
Knowledge among professionals should be improved	COLLOBORATION	
Knowledge and attitudes among stakeholders should be improved	COLLOBORATION	

The survey also raised up matters like lighting in historical areas. The atmosphere should be preserved although a new lighting technique could be used. Accesible lighting was not mentioned among respondents, but it has been studied in some projects of the company.

7 THE LIGHTING CONCEPT CRITERIA

The lighting concept criteria was developed from the base literature review and information from professionals working with lighting design and urban planning processes. The main principles are 1) space 2) user-groups 3) technology and 4) collaboration. Sustainability and resilience are the crossing themes. (Figure 10)

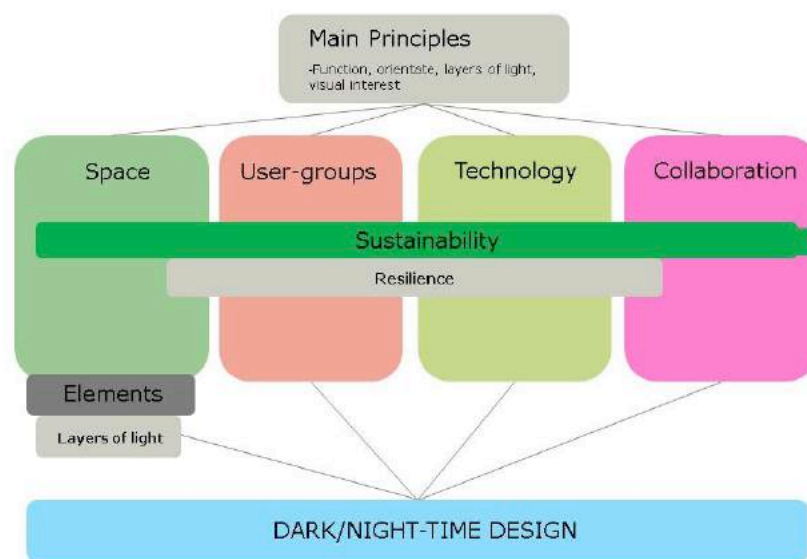


Figure 10. The criteria concept dark-time design

7.1 Space

Experiencing dark-time spaces varies from daytime spaces. Space requires setting its own principles and goals in dark-time design. Analyzing a place in bigger context is essential in place-making with lighting. Dark-time landscape should be considered with new visions, which are not based too much on old standardized lighting technologies, norms and a traditional way of thinking. Dark-time design should consider spatial qualities, users in long term and all different user group activities. The context and the history of the place and

also functions and environmental factors of the place are important. The development of places and spaces needs analyzing and in that way unique features and identifying of them can be done. Those factors make dark-time design unique and pleasant for users in the dark hours as well. The table 4 includes guidelines for space.

Elements in space are processed through in chapter 5. These different elements can create a spesific atmosphere. Using elements from daytime landscape it is possible to improve dark-time landscape and space.

Table 4. Guidelines for space (Arup 2015) modified by S. Suomalainen

Space
Analyze areal, functional and historical context of space. Identify how designs and opportunities relate to local requirements.
Include the needs of user groups of night time into lighting designs
Consider private and public light sources in lighting designs. Include spatial overlays between internal and external.
Use layers of light. Consider use of accent lighting to bring out something in cityscape. Also consider what is wanted to be left unseen.
Evaluate the potential of unused spaces for lighting installations and lighting art.

7.2 User groups

Only functional solutions in the lighting designing should not be the driving force anymore. Better understanding of lighting requirements has made it possible to make better designs and proposals for people to experience environment and enjoy environment. The more light the better is an old way of thinking and it discards user-experience and the context with the environment. The new way of designing is to analyze places carefully at different planning levels and see the potentiality of the lighting design. When designing dark-time spaces it is important to think the life-cycle of the space. The analysis of the space

should include also: Who are the user-groups and how we can get user experience? Will the user groups change during the time? Who will be the end user of the space?

Table 5. Guidelines for user groups (Arup 2015) modified by S. Suomalainen

User Groups
Evaluate the variety of user groups, activities. Assess future demands of area in early stage of process
Think more people centric solutions
Analyze the diversity of social benefits of lighting. For example non-visual effect on health
Consider that enjoyable lighting should not only exist in the city centers but also in residential areas

7.3 Technology

Lighting technology is evolving rapidly all the time and lighting infrastructure is a potential to install smart systems. In dark-time design all potential smart systems should be taken into account and they should be assessed with the needs of user-groups. According to sustainability it is important to invest on resilient smart systems. Technology is also in a key role when glaring and direct lighting are to avoid. Table 6 includes guidelines for technology.

Table 6. Guidelines for technology (Arup 2015) modified by S. Suomalainen

Technology
Evaluate the potential of combining new technologies in
Invest in smart system and technologies that is able to adapt and be reprogrammed in time
Non-visual impacts of lighting. Smart systems can raise awareness the link between lighting and well-being
Use new lighting technologies to prevent glaring and excess light

7.4 Collaboration

Dark-time design should be taken into account at the early stage of a planning process. It should be also an equal part in planning policy and it should be involved in the discussions of decision making. Lighting designs need to be looked over borders to get a similar look in night-time cities. Project areas should be analyzed also over their borders to get understanding of already existing lighting or the planned entire area lighting. Existing light can create contrast in the project area. Collaboration between different parties such as lighting engineers, landscape designers and architects is crucial. Mixing the knowledge of space and more technical details is important to achieve the best result. Table 7 includes the guidelines for collaboration.

Table 7. Guidelines for collaboration (Arup 2015) modified by S. Suomalainen

Collaboration
Use cooperation between different fields of designing to achieve the best result
Use strategies to manage the ownership of light sources. Aim to integrate private and public light sources under the same lighting strategy
Participate residents and other users in planning process.
Take lighting designing into account in an early stage of planning

8 METHODS

The objective of this research is to develop lighting design as a service. Lighting services include user experience and lighting infra. The aim is that lighting service can be conceptualized in order to use it in urban planning processes. The research questions are 1) How to make a working concept to link lighting design and landscape design? 2) How user experience is explored and social and environmental sustainability promoted? 3) To what extent can lighting solutions enhance the usability of public spaces in the dark time and also maintain feeling of safety and security?

The methods used are the analyzes at the master plan and at the detailed plan level. The case areas Jätkäsaari and Tripla Pasila in Helsinki, Finland have been analyzed in the dark-time by using Kevin Lynch method of spatial analyzes the master plan level. After that potential spaces from user experience perspective have been chosen. Those spaces have been introduced with lighting service improvements which have been developed from the basis of the lighting concept criteria (LCC). The analyzes of the lighting concepts at the detailed plan level was made by using layers of light- analyzes to ensure lighting services in a space. (Figure 11).

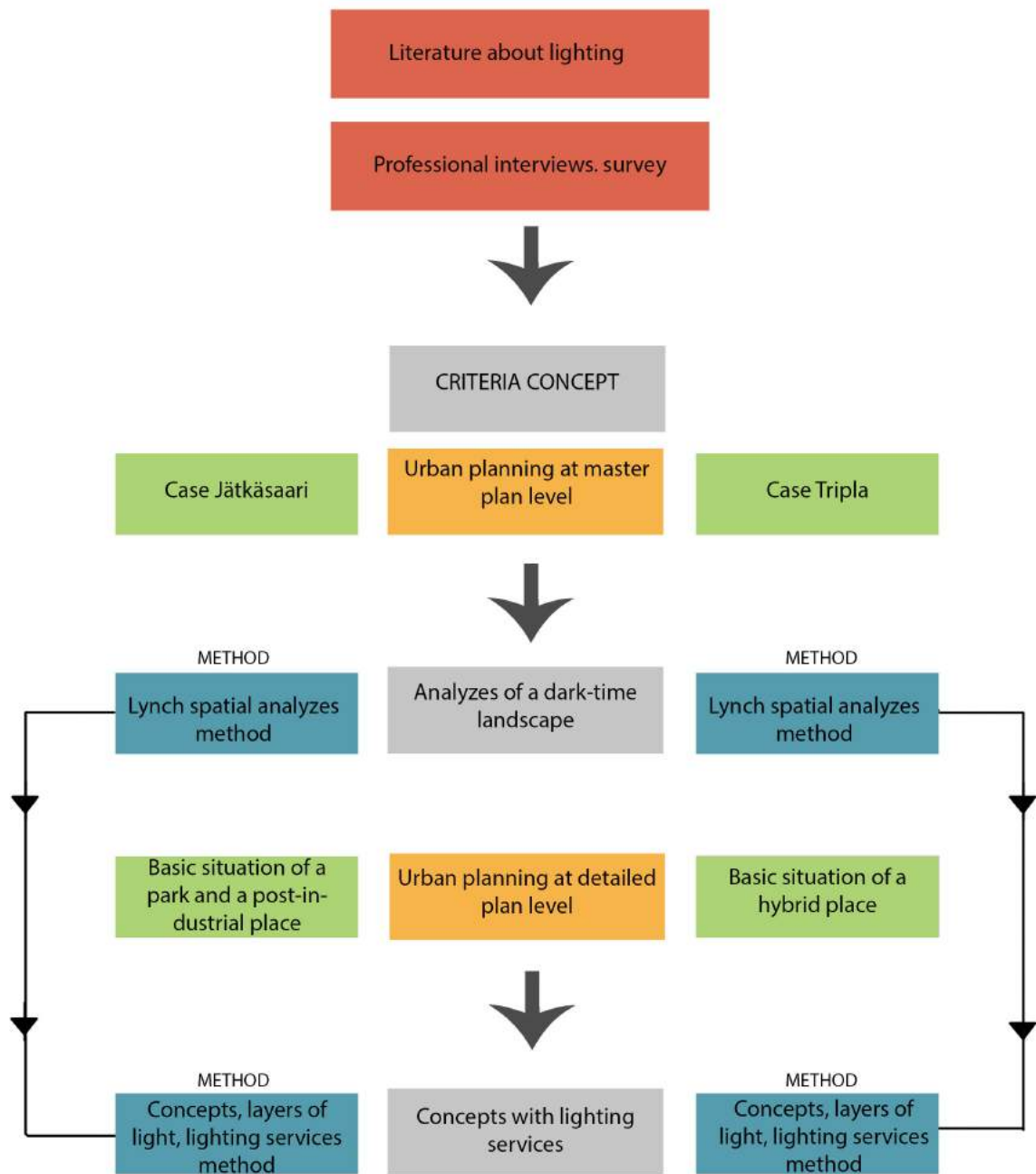


Figure 11. Struture of methods in use

8.1 The Kevin Lynch method of spatial analyze

Kevin Lynch is known as a developer of the theory which studies connections between human values and the physical city structure. Lynch (1960) determines the crucial factors in way-finding and orientation. People do not only read the street numbers, route signs or other guides, but they read the patterns of the environment connected to their individual experiences. To reach the good level for people the city structure should give an emotional security and enables one to move easily and quickly (Lynch 1960: 4). According to Lynch environmental image includes three components: identity, structure and meaning. Lynch determines five factors to analyze the human observations. They are paths, edges, nodes, districts and landmarks (Lynch 1960).

8.2 Layers of light analyze

The layers of light is to analyze environment in different way than Kevin Lynch method of spatial analyzis. It is based defining the layers of light in environment despite what is the light source. (Arup 2015: 25). That is why this should work as a tool in discussion with several property owners. The yellow in pictures visualizes 1) ambient, 2) accent, 3) orientation and 4) feature layers (Figure 12, 13, 14 & 15).



Figure 12. Ambient layer



Figure 13. Accent layer



Figure 14. Feature layer



Figure 15. Orientation layer

9 RESULTS (OF STUDY CASES)

The results are the dark-time analyzes at the master plan level and the three lighting concepts at the detailed plan level (Figure 16).

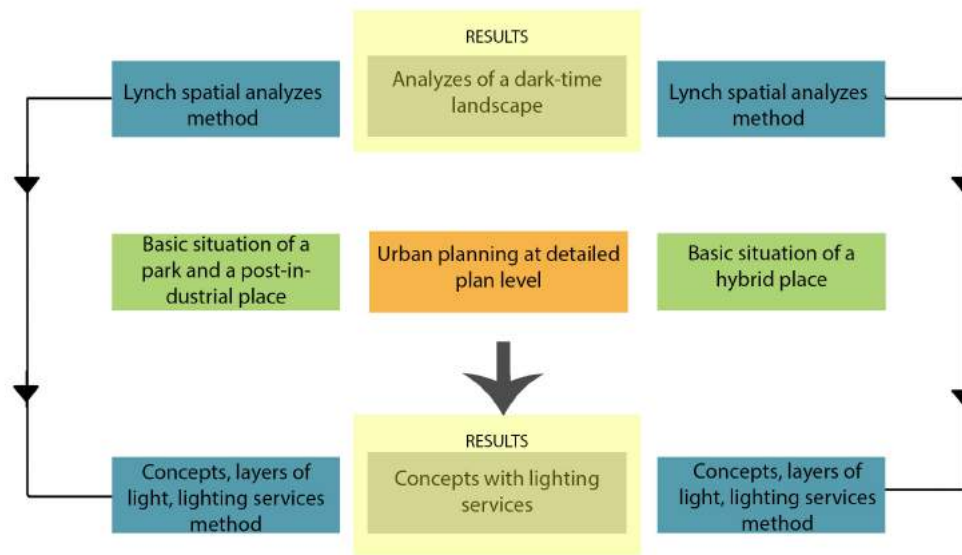


Figure 16. Results

The study cases are new developing areas in Helsinki, Finland. Jätkäsaari is new residential area with public services. Tripla is a new mall and service centre in Pasila.

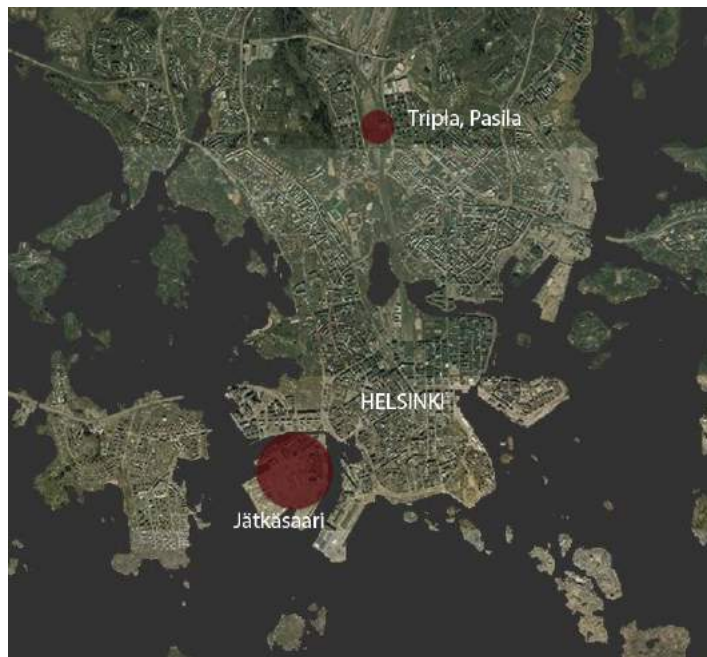


Figure 17. Location of cases in Helsinki, Finland

9.1 Case Jätkäsaari

The Jätkäsaari area is part of the neighbourhood called Länsisatama. The area was earlier used for industry and harbour businesses and it was brown land area. Now the Jätkäsaari area is changing to a residential, commercial and service area next to the Helsinki centre. In the year 2015 there were 5845 people living there. The area of Jätkäsaari is about one square kilometer. It is predicted that in the year 2030 Jätkäsaari is a place for 18000 people to live. In future the density of population in that area will be 18000 per one square kilometer.

The downtown look of Jätkäsaari forms of good services, architecture, bikeroads and pedestrian paths. The new blocks look like Helsinki downtown closed block areas. There area at the basement of buildings services such as caffeterias and shops.

9.1.1 The analyzis of the area

Kevin Lynch method of spatial analyzes is carried out for dark-time landscape analyzing spaces and places when they are illuminated. This analysis uses the expressions of Lynch. They are paths (bikes, pedesterians), edges, districts, nodes and landmarks. (Figure 19)

Jätkäsaari has a long costline with the sea. Buildings that locate in front of the sea are de-limiting the space with their lighting, because the sea is dark in the night-time. Harbour terminals that locate in the East and at the Southeast side of the block has the view to the sea. The lighted routes by the sea are also a bordering element of the area. The dense built areas cause also the feeling of the limited area in the middle of the block areas. Hyväntoivon- park is bordered by large city blocks which at night create compact and more unified area feeling.

The dark-time analyzis done by using Kevin Lynch method of spatial analyzes shows that there are a few larger districts in Jätkäsaari. Hyväntoivon-park creates a district in the middle of the area. Due to the shape of the park there are no long views. The views are limited by the housing areas on the edges and the both sides of the park. The sport fields are located next to Bunkker building. They create the feeling of the unified and functional district.

It is the most open district in the Jätkäsaari area. Small public squares form other smaller districts areas in Jätkäsaari in the dark time. In Southwest part of Jätkäsaari parks form districtal area by the sea. Important paths go through Hyväntoivon-park all the way to the paths next to the sea.

Nodes are important area in space and place making. Because the closeness of the sea, Jätkäsaari has plenty of bridges. There are many bridges in Jätkäsaari and the create interesting nodes. This creates a node in dark-time landscape when the roads are illuminated according to the normal regulations.

Lighting creates landmarks in the dark time when those would not be marked as a landmark during the day time. In the case study of Jätkäsaari this is an emphasizing factor. For example the Bunkker building stands out by its architecture from the other buildings and with lighting it can create an illuminated element which gives even a unique character to the area. Bunkker building also locates next to the more open area which enabling long views.

The other bigger landmark in dark-time Jätkäsaari landscape is a new ship terminal. An illuminated ship terminal with an unique architecture creates another landmark in the dense neighborhood. It is not a very high building complex, but its glass surfaces are illuminated bringing light to the surrounding areas. In this analyzes also three other buildings are marked as landmarks. As high housing buildings they are illuminated, but they also are potential places for architectural lighting,



Figure 18. Jätkäsaari urban elements analyze map

The Kevin Lynch method of spatial analysis in the dark-time at the master plan level determines places from the basis of human experience. It can be seen that many places and areas are characteristic to Jätkäsaari and they have also been determined in the master plan in the day time landscape. Yet, it is important to analyze them in dark-time landscape. Bridges are natural nodes, whereas landmarks in the dark-time are not depended only on if they are high buildings. The landmark character can be built up if it can be seen lighted from the human perspective. Landmarks are important in orientation and way-finding, not to underestimate the meaning of identity. The character of the large park area will change when trees will be mature. However, the experience of user is connected to the lighting solutions. It is possible that the dark-time landscape should be analyzed again after 10-20 years (Figure 19).



Figure 19. Jätkäsaari Lynch method of spatial analyze map

9.2 Case Tripla in Pasila

The Tripla area represents in this Thesis a multifunctional hybrid block of services and logistic, whereas Jätkäsaari is a housing area with several services. The Tripla is under planning and construction and is should be ready by the autumn 2019. It comprises a mall, a station area with railway and tramline stations, a hotel and public outdoor and indoor spaces and housing. It has no specified lighting strategy, but accessible lighting should be achieved in all public places in Helsinki and additionally lighting should promote also housing. In this case study part of the Tripla outdoor areas have been analyzed. The main services at that area are a railway station, a mall and tower buildings (Figure 20)



Figure 20. Pasila urban elements analyze map

9.2.1 The analyzes of the area

Kevin Lynch method of spatial analyzes is carried out for dark-time landscape analyzing places and spaces on the basis of human experience. The paths (bike, pedestrians), edges, district, nodes and landmarks are important in public places and for orientation and way-finding. (Figure 21).

The analyzes show that the districts can be experienced at the square in the front of the mall and the main entrances. The paths are natural ways to and from the main mall building and the railwaystation. Because of the dense structure, the paths are between buldings. The other blocks in the surrounding create borders to the Tripla area. A node of this area is a glass corridor over the tram tracks.



Figure 21. Tripla Pasila Kevin Lynch method of spatial analyze map

9.3 The dark-time lighting service concepts

The dark-time lighting service concepts were prepared to for potential spaces of urban life in the analyzed case areas. In Tripla Pasila a district areas and a path is a hybrid area between buildings

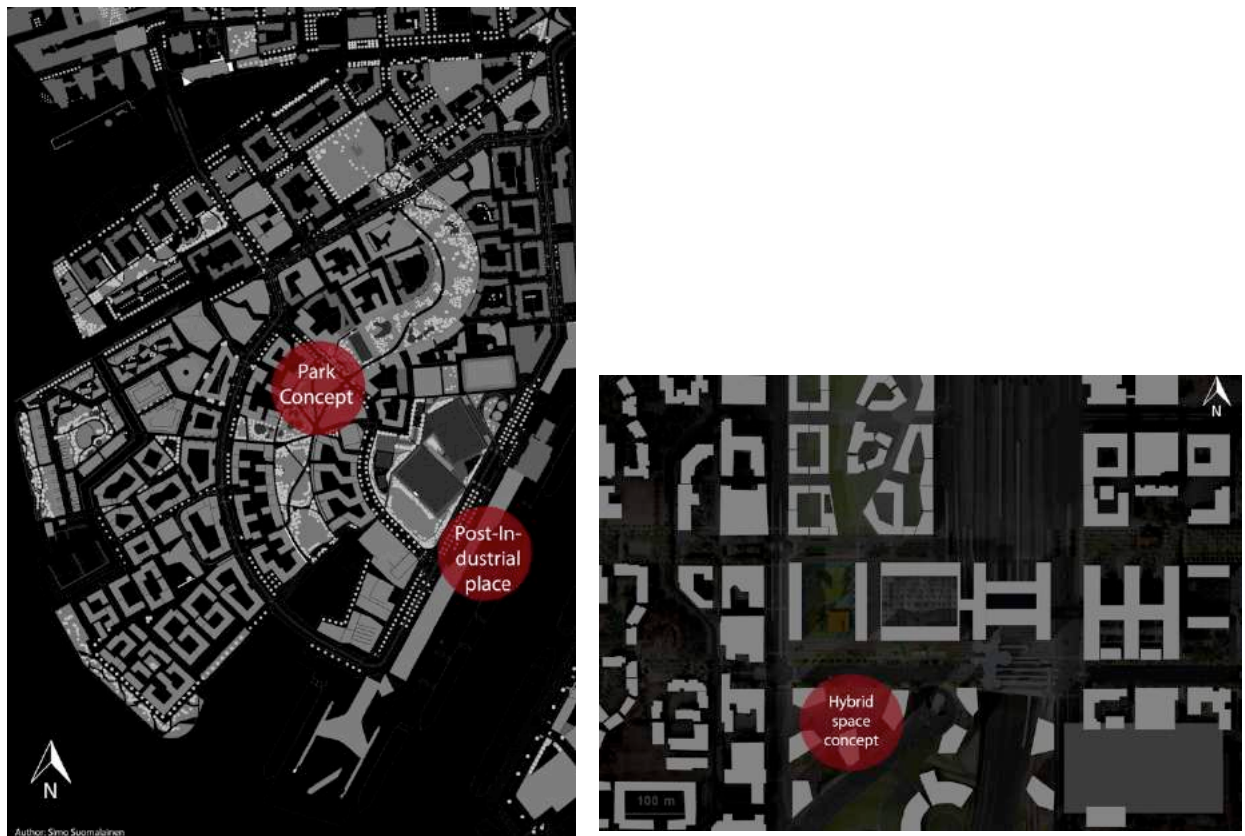


Figure 22. Location of concepts places

First I have presented the three areas both in daytime and in dark-time to show the improvements to the present situation. The improvements are based on the lighting concept criteria (LCC). Then I have used the layers of light to define the lighting solutions at the different levels of space. In an each concept case the three layers of light has been used. The lighting services of the concept cases have been defined and spaces that light creates have been presented in the cross-section pictures.

9.3.1 A park

Parks are a part of the city structure. According to their size and situation they can be influenced by surrounding lighting in different ways. In dense city areas small parks can be very light places because of the surrounding lighting, whereas larger parks can have dark areas despite their situation in a city. It has been typical to illuminate roads in parks, but because they are often considered scary places, it has been necessary to add lighting elsewhere. In parks nature and ecology are important challenges in terms of lighting.

A daytime and a dark-time park

The daytime park has a typical look. Trees and other vegetation are the main elements. Lighting infrastructure is nearly invisible and the meaning of it is only to create light in dark-time. Lighting is typical for a park, because only paths and roads have been illuminated. There is old technology in use and the colour of the light is a yellow (Figure 23, figure 24).



Figure 23. A daytime park



Figure 24. A dark-time park



Ambient



Accent



Orientation

Figure 25. The layers of light in a park

The layers of light in the park express lighting at different levels in space (Figure 25).

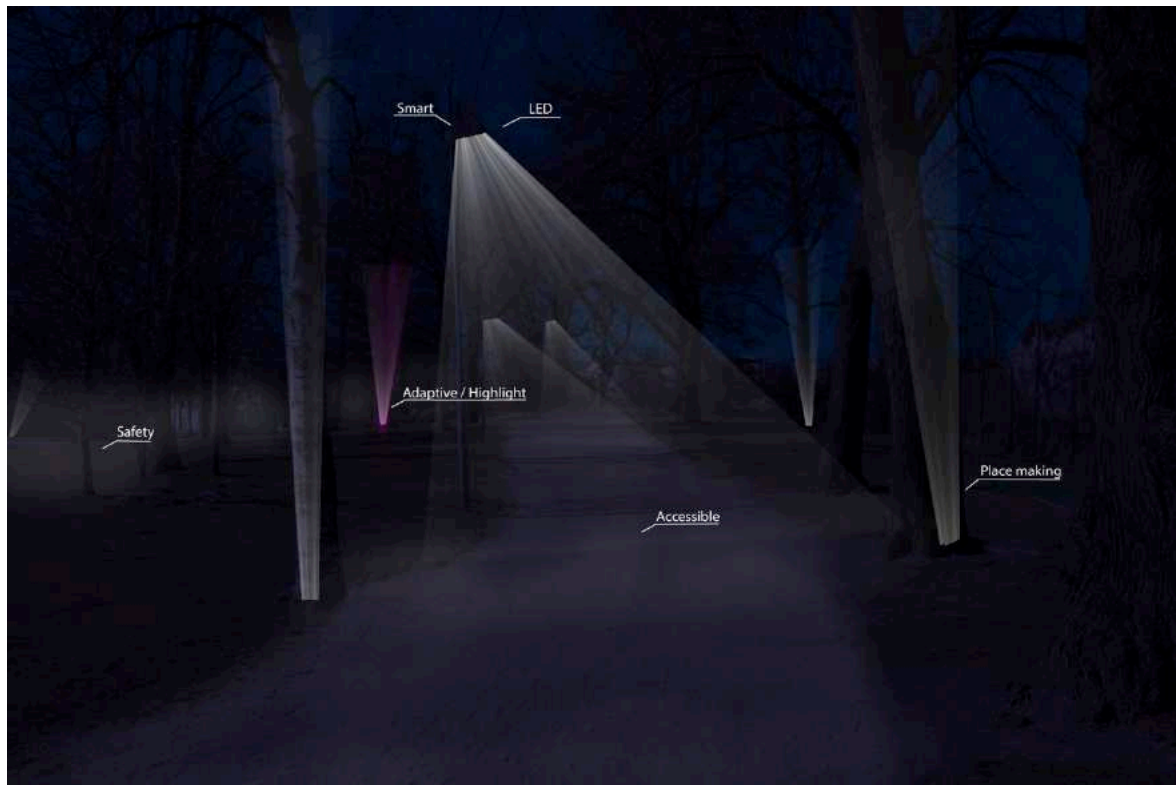


Figure 26. Make over of a park

The improvements are introduced firstly based at the layers of light analyze (Figure 27) and secondly based on the theory of space (Figure 28).

The lighting technology at the ambient level uses LED technology and the colour of the light is white. White colour renders all colours in environment into natural colours. Other light sources may have changing colour systems, but they have a special purpose in terms of place-making or adaptive lighting. Used lighting technology is LED-technology because it is an energy-efficient solution. Accessible lighting can be achieved when light does not create glare or deep contrasts. Continuous lighting at the ambient level produces the best result, but when contrasts are needed, for example in stairs, it will be a solution at the ambient level.

Lighting of trees at the accent level brings safety, because also the surrounding area is lighted and it does not make a deep dark contrast. Trees can be lighted with different shapes of light beams. Light is steered up along trunks to create visually interesting elements.

The oriental layer lighting concentrates on guiding signs. A lighted tree line works also as a guiding element in a park. Any special features in a park should be considered to have a convenient lighting. It can create orientation and feeling of place making.

Lighting infra solutions can be used as a visual element or light sources can also be embedded. Smart technology can automate lighting and it can also be integrated into lighting poles. Information about local climate or sharing information and best practices can be a local Living Lab. Directing of lighting sources and preventing glare are important when avoiding lighting pollution. There are standards and regulations for lighting at the moment. Re-cycling of lighting infra is also a part of sustainability and resilience.

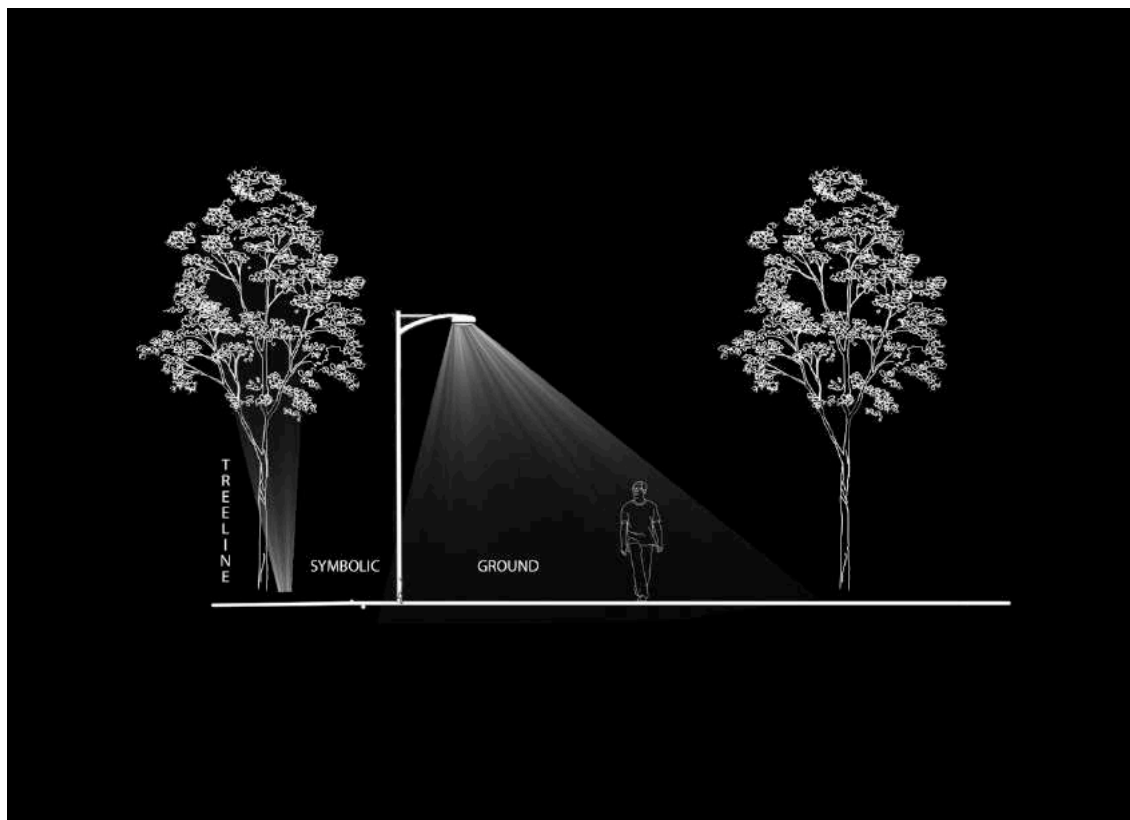


Figure 27. Light creates spaces and place-feeling

Spaces can be created by lights. Visual and movement corridors are typical and they can be strengthened by treelines. Light can also make ground space depended on used light beams. Symbolic lighting promotes the feeling of the entry and the feeling of a place-making.

9.3.2 A hybrid space

A hybrid space in this study is for pedestrians, but cyclists and service cars are allowed to use the area. The street areas have a multifunctional use and pedestrian street areas can be important public meeting places. This hybrid space comprises commercial properties and housing properties. Additionally a department store with concrete walls and shop windows are situated at the area.

A daytime and a dark-time hybrid space

The lighting infra in the area is visual and typical to city architecture and the original lighting poles are situated in the one side of the street. Light is steered to the direction of the street space. Pedestrian streets does not require any specific levels on lighting, but accessible lighting is a target in an urban environment. Street trees are potential features in urban environment. They have a different look in summer and in winter. If the store lights are switched off and there is no special lighting, the area is typical pedestrian street area in any part of a city (Figure 29, 30).



Figure 28. A day time hybrid space



Figure 29. Dark-time hybrid space



Figure 30. The layers of light in a hybrid space

The lighting solutions make the hybrid space more attractive and safe. At the ambient layer the necessary level of light for accessibility has been achieved by using lighting poles and light stones. The light stones work also as guiding elements at the ambient level.

At the orientate layer shop windows work for way-finding and orientation. Safety can be achieved when the lights are on during the dark-time.

At the feature layer show windows or the concrete walls can also be used in new ways of adaptive lighting. That is one possibility to promote place-making. Lighting should be steered to the right places and glare should be avoided. Integretation of lighting into city furnitures give enourmous possibilities. Additionally trees give possibilities to special lighting solutions (Figure 31, 32).

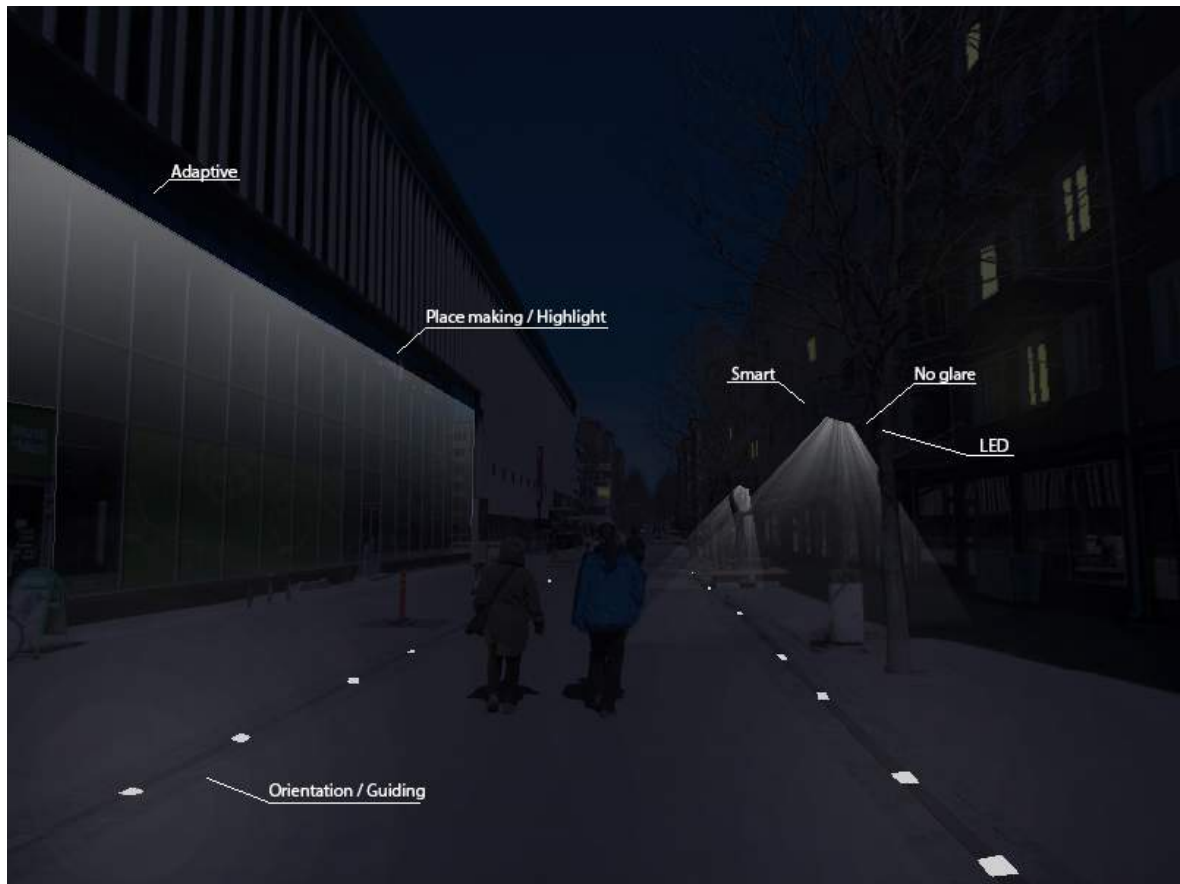


Figure 31. Make over of a hybrid space

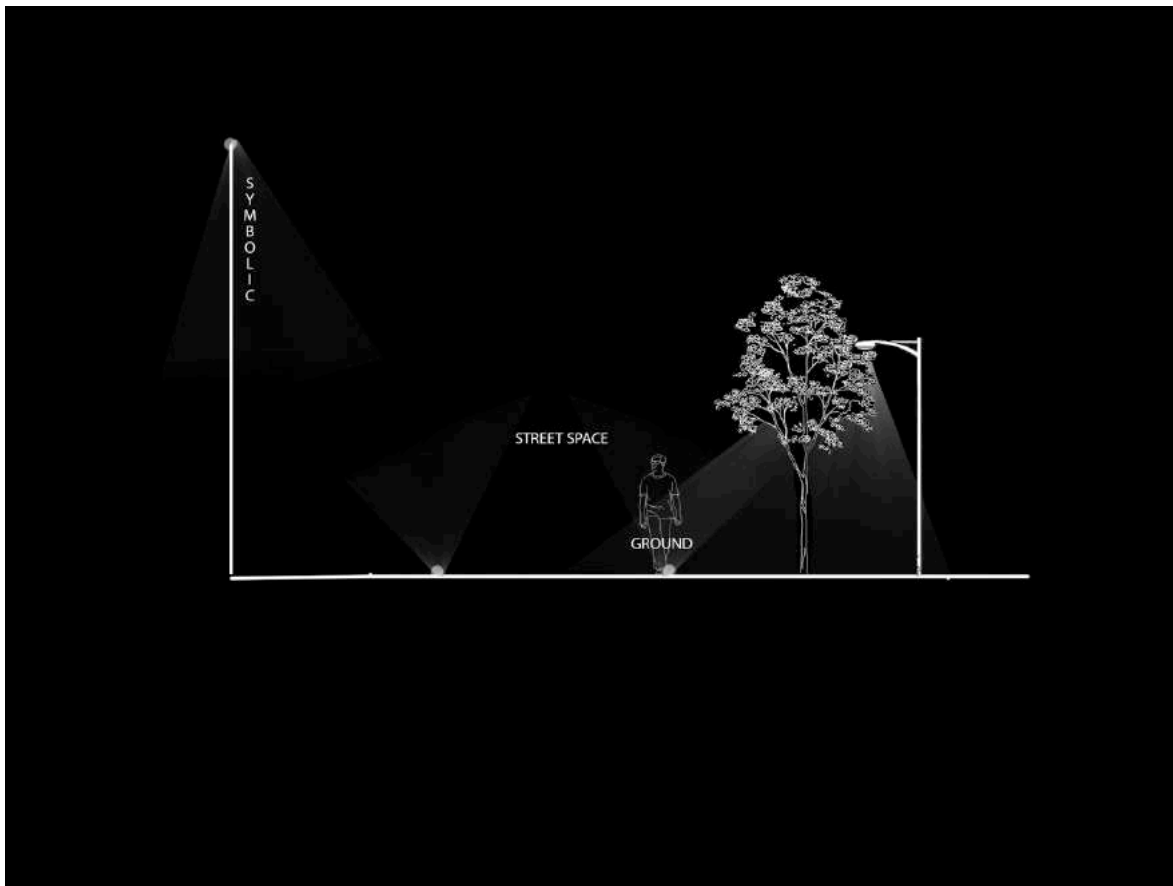


Figure 32. Light creates spaces and place-feeling

A hybrid space lighting creates space between buildings. Different lighting solutions create spaces on the ground. Symbolic lighting can be used to catch attention (Figure 33).

9.3.3 A post-industrial space

Post-industrial places are in trend to be transformed into new public spaces. Often old factories that were once locating in the centre of city are shutting down their business or have already done that. Now those old places are effectively adapted into public city spaces because of urban sprawl and need of new land. In many cities some of the old industrial buildings can be part of the new area. They might be protected buildings or they will be reconstructed for housing or for public use.

A daytime and a dark-time post industrial area

Lighting in industrial areas is only for technical purposes. The lighting poles are rough holding up electric wires and spotlights. The surrounding features can be historical, but they can also be qualid (Figure 34, 35).



Figure 33. A daytime post-industrial place



Figure 34. A dark-time post-industrial place



Figure 35. The layers of light in a post-industrial areas

The improvements of a post-industrial case area are to show the possibilities of daytime and dark-time contrasts as well as possibilities of unique features. The improvements are introduced firstly based at the layers of light analyze and secondly based on the theory of space.

The old building has a graffiti wall which works as an example of highlighting the past. Highlighted spots can be historical and they may have some other specialities. The upper part of the building has not been illuminated. Lighting technology used is LED with white colour. Post- industrial areas offer good settings for artlighting.

At the ambient level an old lighted train track is a guiding element. This solution works also at the orientation level.

At the feature level lighting of trees creates an interesting element closing the view to the car parking.



Figure 36. Make over of a post-industrial area

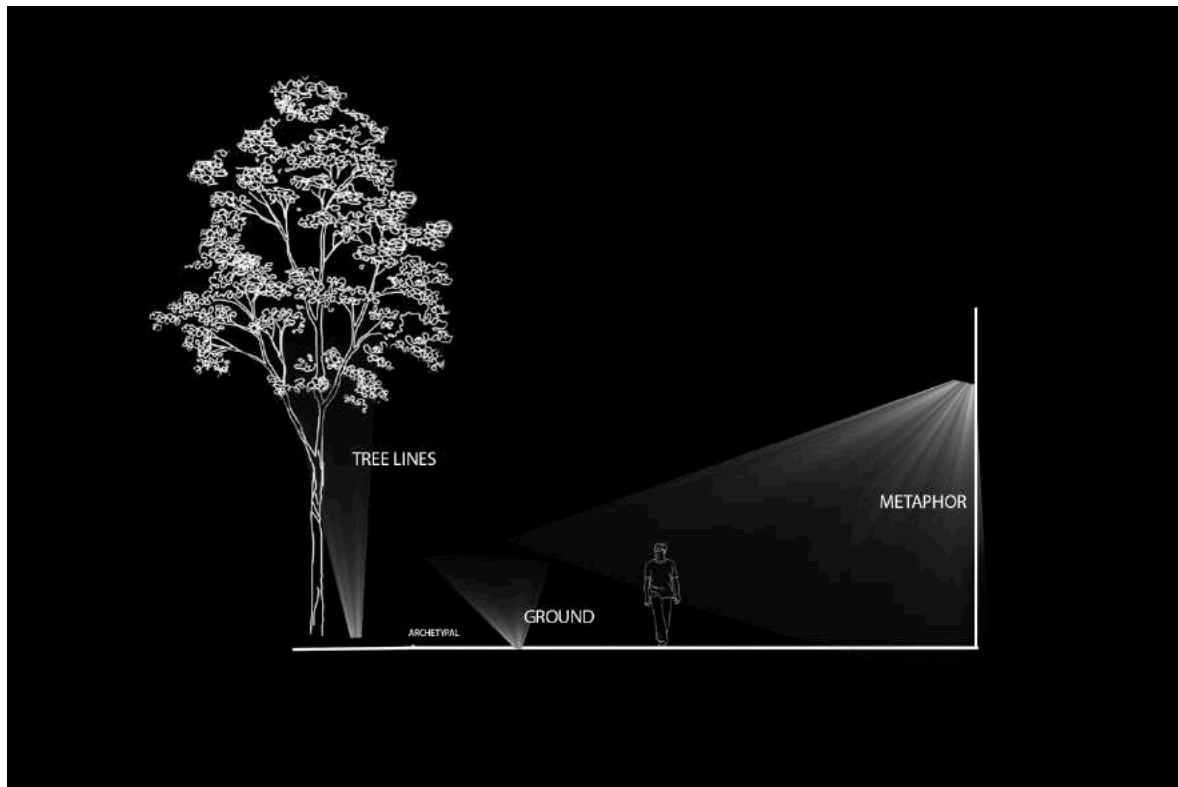


Figure 37. Light creates spaces and place-feeling

At the post-industrial area spaces can be created by using innovative lighting technologies. Lighting of treelines makes the effect of a wall. The lighting solutions steered on the ground or from the ground create different feeling of space. A metaphor is a lighted historical feature or a metaphor can be created by lighting technology. Movement corridors and visual corridors lighted with adaptive lighting according a user create space in different way than continuous lighting.

10 DISCUSSION

Lighting strategies have been made to cover city areas to manage lighting solutions. They usually outline guidelines for different city zones. They have also made for existing urban areas and new areas, when they in that the smaller scale define technology, material and architectural targets in more specified way. Still they are guidelines and they do not consider lighting as a service in a certain space. Accessible lighting and special lighting solutions promoting identity has been recognized in strategies. These are determining factors when lighting design processes are carried on and lighting solutions are conceptualized as lighting services. Lighting services include user experience and they can be a new way to deal in urban planning processes instead of choosing beams.

Lighting service concepts have been developed from the basis of lighting concept criteria (LCC) for three different environments. First the analyzes at the master plan level helped to analyze a city structure, patterns and elements which are important for dark-time landscape architecture and to understand user experience. In this research the Kevin Lynch method of spatial analyzes gave results about patterns and spaces connected to human experience. The good quality environment and place-making can be achieved when humans can read their environment (Gehl, Gemzøe, Kirknæs, Søndergaard 2006; Thawaites, Simkins 2005). The lighting services of the concept cases are accessible lighting, safety, orientation and way-finding, adaptive lighting and special lightings like highlightings, art lighting or Christmas lighting.

Creating spaces and places with lighting have not been recognized lighting services earlier, but it is assumed that because good quality places in cities can improve public open space usage, they can also do it in the dark-time. Potential spaces to improve quality with lighting are necessary to map and then it is important to strengthen them by suitable lighting solutions. As known architecture is interaction between humans, and theories of landscape architecture raise user experience for dark-time landscape design projects. Though user experience should also be based on the feedback and the evaluation of the realized projects. Participation and collaboration are seen as important factors in lighting design development. The more knowledge about lighting is in design processes the more mutual understanding is expected.

Technology will give possibilities to implement innovative lighting solutions. The concept cases do not give answers to an every solution, but they give frames to discuss about them. In the three different cases light pollution shows up in different ways. First of all it is a problem in a global scale and in terms of human health. This is the main thing to understand and adding extra lighting is not a solution. In parks light pollution concerns flora and fauna and people. Inventory of plant and animal species and knowledge about ecological influences are necessary when planning lighting in parks. Technology and lighting infra can be chosen so that lighting pollution and human and ecological disturbance can be avoided. In the two urban concept cases lighting pollution is also a threat. Glare is a direct effect of it when some other of effects on human health in terms of the circadian rhythm should be avoided by using accurately controlling according the use of the area. Light disturbance is also depended on the colour of lights and on the amount of light luxes.

Safety is a perceived experience and that is why it is difficult to achieve perfectly. It is a basic lighting service and solutions to ensure it are depended on the area, the structures and use of it. Lighting effects on safety are still important to know. The small lapses can cause feeling of insecurity whereas small improvements can promote safety. The dusk hours in cities have been divided into eight categories which is a concept to think of function of 24-hour city and its safety (Arup 2015). Accessibility is safety for some users. Still it is important to understand how accessible lighting is created. The accessibility criteria for urban areas in Finland includes guidelines for lighting, though it seems that knowledge about accessible lighting is increasing among professionals working with lighting. It is expected that new guidelines for accessible lighting will be made in a near future.

Lighting services can be an answer also to global and EU- programs. The knowledge and best practices about sustainable solutions should be used in lighting design. They are decisions about used lighting infra, technology and energy consumption. The social aspect is a part of the sustainability and economy, ecology and sociality are always searching for a balance. Circular economy aims to create endless circular material flows and the concepts of lighting services is a way to deal with that, because lighting as service in the future can include materials and maintenance, and charges can be shared among property owners. Resilience in lighting solutions are implemented on the basis of sustainability, but resilience can also be seen in a connection to Smart cities (Burgess, Shahidehpour, Ganji, Con-

nors 2017). Resilience solutions can also be part of lighting services when using smart technology to reach for example a climate resilience city. Lighting technology can be a means of communication to understand environmental changes. LEED and Breeam certifications have regulations for sustainable solutions of outdoor lighting of buildings. When dealing with the lighting services the target is to plan the entire built environment and not only surroundings of buildings.

Basic theories of spaces in landscape architecture work for dark-time landscape design. Lighting infra as a part of a city architecture is known and possibilities of it in dark-time landscape should be thought out in lighting design process. Not only lighting poles, but source of light, its shape and placement are important factors in creating pleasant places.

11 CONCLUSIONS

Collaboration is a working method nowadays producing best solutions in urban planning. Lighting designing has been taken more and more into planning processes whereas it was a duty of electricity engineers some time ago. That is why all aspects can not be understood in a same way and also some offending attitudes have been met. First, the lighting concept criteria (LCC) was summarized in this research to combine the background information about the necessary principles of actual lighting design knowledge. Secondly, the lighting service concepts were developed to show the necessary lighting services in three different environments. The concepts are used to plan lighting services. In the next phase technical solutions can be decided. The concepts can be developed for other urban areas as well.

The end-user of lighting is a human. This research suggests that to manage lighting design and produce best solutions for users the theories developed to map experimental spaces from human perspective in urban areas are important to use. When at the detailed planning level user experience should be considered the lighting service concepts and checking them at the light layers will help in design processes. Sustainable development solutions have been guided in city lighting strategies. However there is a possibility to fail it if lighting solutions are not made without thinking of the entire environment and the life-cycle of ma-

terials. Lighting services in urban environment have a possibility to promote circular economy and achieve sustainability in many ways.

Lighting solutions enhance usability when proper analyzes have been used to map user experience and potential spaces to improve it have been found. Usability is a summary of many factors. The lighting services raises the factors like accessibility, safety and identity. Still proper knowledge about all factors is not sufficient. User experience is essential and it should be utilized also as evaluation and feedback of realized case. They can be considered to a certain point keeping in mind that safety and security are also perceived experiences. Additionally it is important to understand the use of the area in different times of the dusk hours. It will give guidelines to more accurately control of lighting by using new technology. Spaces and place- making are important for people in their living environment.

Lighting technology evolution will go on developing rapidly. Lighting can be embedded into building and new technology will help in miniaturization of solutions. Human evolutionary process is much slower. That is why it is important to be aware of user experience and that lighting is a service that can also produce new ways of dealing with the entire lighting life-cycle.

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APPENDIXES

Appendix 1

Axial coding of the survey

Respondents and their codes

Designer	DG
Infra Engineer / Designer	IED
Planning Chief	PC
Lighting Designer	LD
Architect	ARC
Landscape-Architect	LARC
Assistant designer	ASD
Project manager	PM

	GOOD LIGHTING	PRIOR TO BE DEVELOPED	DARK TIME LANDSCAPE	3D IN LIGHTING DESIGN	IMPROVEMENTS OF LIGHTNING DESIGN PROCESS	WHAT KIND OF SERVICES	ELEMENTS TO PROMOTE IDENTIFIABILITY	CHALLENGES	USERS
DG	Good design, Pleasant lighting, Lighting that supports usage	Smart lighting		3D – modeling is advantage in lighting designs.	More expertise in lighting designing		Lighting equipments	Results are really visible after lighting is implemented in places. When you can see glares and how other light sources are effecting in contrast	Users are not really included in lighting designing process
IED	Safety, No-glare, Aesthical	Design of the lamps, No to create glares in environment	Lighting is often thought as just necessary factor which is planned just where it happens to fit	It helps, but I have not been in project where lighting was modelled also	-	Lighting art, Identity enhancing services,	Lighting promotes identity of a place	Attitudes. Do people and other stakeholders appreciate well designed lamp posts.	-
PC	Design aims to specific goals, Good lighting takes in notice environment , daily hours, season, ambience, user groups.		Place, Atmosphere, Experience	3D- modeling visualize and verifies facts.	Basic concepts should be made and done. Analyze different solutions and implement those on real projects to bring solutions in lighting.	Combining a variety of technologies with lighting equipment, Interesting lighting visual night time landscape. Finland could be one of the leader countries in this	Lighting promotes identity of a place	Marketing of well designed lighting	Basically only level that user can participate in lighting is to call maintenance if a lamp or light is broken, - Good idea would be that lighting modeling would presented to users and they could give a comment if many options
LD	Conscious designing, Human centered, safety, Orientated, Supports cityscape	Awareness (Lux-standards and safety drives the planning) <- Old fashioned and not well	Dark time landscape are considered too little in planning phases	3D- modeling produces selling and realistic looking designs, even though it is hard to model	More multidisciplinary and different stakeholder engagement, eg the civic perspective and local businesses	Safety moving outside, Attractive night time city that does not "die" during dark hours	Lighting can strengthen the already existing place identity	Old habits and thinking – new ideas and new ways of thinking might not be even considered.	In lighting happenings such as Guerilla lighting, Info events that are concentrating of projects

		rationalized, not ecologic		lighting solutions because the programs do not know every light source in sight. Good work tool if the results concern critical					
ARC	Safety, Comfort, Orientation, Attractive, Accessable, No-glare and light pollution, energy saving, high lighting city scape.	Dark time cityscape, lighting of beautiful facades,	Some places should be left to be unlighted,	3D-modeling helps, but lighting will be implemented anyway. Modeling helps decision making	Lighting should be included in already in general design phase. The important part is right-timely	parking spots and places info tracker etc.	An example of the Siilo (Silo) in Kruunuvuorenranta. That's what has created a strong identity for the whole region.	Lack of professionals. Education does not happen in Finland. Stakeholders do not have enough knowledge.	Users and residents can not really participate in lighting designing, they will more tell if something is broken or something is making glare in home
LARC	Professional design, innovative, energy efficient, Life cycle-orientated, Light color, A	Uniformity over the planning borders, design lamp post, wooden pillars	In zoning process should be though that environment is not over lighted. Some places need to be dark for different animals species	It helps in process	Clarify design responsibilities, role and interface.	Interactivity, modifiable. For example people could turn off the lighting in sightseeing place to see better in night hours. Experience in night time landscape	Lighting promotes identity of a place	Landscape designers does not have enough knowledge to design lightings, the connection between electrical engineer and landscape designer is poor. Lighting is often designed based on numbers.	User could give a comment within park or street project is been commented. – Comments and feedbacks will be concerned in planning process
ASD	User-Centered lighting, Lighting should be where it is needed.	More playfulness with lighting	Items and places that could be highlighted.	It helps in process	-	Joggers could have own implementations in jogging path lighting infra. Different applications that use lighting infra	Unified lighting equipment. Similar colors, Link lighting equipment in history	Needs, resources.	I think they really can't participate
PM	Safety, Suitability, Atmosphere	Suitability within place	At the moment too little, Dark time creates a new dimension in landscape and experience in environment	It helps in process	The technical development of the products has been amazing. Now it would be important to test new options, make modeling and just practical experiments	Use lighting to make navigation easier in night time landscape	Lighting promotes identity of a place	Options – There are so many of them. Some times there is a lack of light and sometimes there is too much light	Via Internet or Social media. Maybe residential info events

Hereby I, Simo Suomalainen

Birthday 14.07.1989

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